RAJASTHAN COLLEGE OF AGRICULTURE : UDAIPUR

Syllabus

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

Rajasthan College of Agriculture, UDAIPUR

PROGRAMMES

1. M.Sc. (Agril. Econ.)
2. Ph.D. (Agril. Econ.)
3. MBA (Agri-Business)

COURSE REQUIREMENTS

M.Sc.

Field of specialization	Agricultural Economics, Agricultural Marketing, Agricultural Finance, Agricultural Development, Agricultural Production Economics
Core Courses	AGECON 511, AGECON 512, AGECON 513, AGECON 521
Optional Courses	AGECON 522, AGECON 523, AGECON 524, AGECON 531, AGECON 532, AGECON 533, AGECON 534, AG ECON 535
Minor & Supporting courses	STAT 511, STAT 522, EXTEN 533 or per decision of advisory committee in view of research problem
Non credit compulsory courses	PGS 502, PGS 503
Deficiency courses	Nil or as deemed suitable by advisory committee

Ph.D.

Field of specialization	Microeconomics Production Economics, Agricultural Development and Agricultural Marketing and Prices
Core Courses	AGECON 611, AGECON 613
Optional Courses	AGECON 612, AGECON 614, AGECON 621, AGECON 622, AGECON 623 & AGECON 624
Minor & Supporting	STAT 611, STAT 612, EXTED 635 or per decision of

courses	advisory committee in view of research problem
Non credit compulsory courses	PGS 502, PGS 503 (Exempted if done in M.Sc.)
Deficiency courses	Nil or as deemed suitable by advisory committee

MBA (Agri-Business)

Field of Specialization	Agricultural marketing, Financial Management, Agricultural Risk Management, Agricultural Input Marketing, High Value Crop Management
Core Courses	ABM 514, ABM 515, ABM 516, ABM 522
Compulsory Courses	ABM 511, ABM 512, ABM 513, ABM 518, ABM 521, ABM 523, ABM 524, ABM 526
Optional /Elective Courses	ABG 531, ABG 532, ABG 533, ABG 534, ABG 535, ABG 536, ABG 537, ABG 538, ABG 539 ABI 531, ABI 532, ABI 533, ABI 534, ABI 535, ABI 536, ABI 537, ABI 538, ABI 539
Basic Supporting Courses	ABM 517 , ABM 528, ABM 529
Non-Credit Compulsory Courses	ABN 541, ABN 542
Deficiency Courses	Nil or as deemed suitable by advisory committee

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

DESCRIPTION OF COURSES FOR UNDER GRADUATE

AGECON 121 PRINCIPLES OF AGRICULTURAL ECONOMICS Cr.Hrs. 2 (2+0)

Theory :

Economics: Meaning, Definition, Subject matter, Divisions of Economics, Importance of Economics. Agricultural Economics: Meaning, Definition. Basic Concepts: Goods, Service, Utility, Value, Price, Wealth, Welfare. Wants: Meaning, Characteristics, Classification of Wants, Importance. Theory of Consumption:

Indifference curve and their characteristics. Law of Diminishing Marginal utility: Meaning, Definition, Assumptions, Limitations, Importance. Consumer's surplus: Meaning, Definition, Importance. Demand: Meaning, Definition, Kinds of Demand, Demand schedule, Demand Curve, Law of Demand, Extension and Contraction Vs Increase and Decrease in Demand. Elasticity of Demand: Types of Elasticity of Demand, Degrees of price elasticity of Demand, Methods of Measuring Elasticity, Factors influencing elasticity of Demand, Importance of Elasticity of Demand. Supply: meaning, law of supply. National Income: Concepts, Measurement. Public Finance: Meaning, Principles, Services Tax, Classification of Taxes. Cannons of Taxation. Public expenditure: Meaning, Principles. Inflation: Meaning, Definition, Kinds of inflation.

References :

1. K. K. Dewett and J. D. Varma, 1986, **Elementary Economic Theory,** S. Chand & Company, New Delhi.
2. P. A. Samuelson and W. D. Nordhaus, 1987, **Economics,** McGraw-Hill, Singapore.
3. S. K. Misra and V. K. Puri, 1996, **Indian Economy,** Himalaya Publishing House, New Delhi.
4. G. B. Jathar and S. G. Beri, 1996, **Elementary Principles of Economics,** Oxford University Press (10th Edition), Delhi.
5. Berkeley Hill, 1980 **An Introduction to Economics for Students of Agriculture,** Pergaman Press, Oxford.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON 211 AGRICULTURAL FINANCE AND COOPERATION

Cr. Hrs. 2 (1+1)

Theory :

Agricultural Finance: Meaning, Nature and Scope. Agricultural credit: Meaning, Definition, Need, Classification. Credit Analysis: 3Rs 5Cs and 7Ps of Credit, Repayment Plans. Nationalization of Commercial Banks. Lead bank scheme. Regional Rural Banks, Scale of Finance. Meaning and Objectives of higher financing agencies Viz.: RBI, NABARD, World Bank. Crop Insurance: Meaning, objectives, Advantages and Limitations in Application. Agricultural Cooperation: Philosophy, Principles. History of Indian Cooperative Movement, Cooperative Credit Structure: PACS, FSCS. Successful cooperative systems in Gujrat, Maharastra, etc.

Practical :

Time Value of Money. Compounding and Discounting, Tools of Financial Management: Balance sheet, Income statement and Cash flow analysis. Estimation of credit needs and determining unit cost. Types of Loan Repayment, Visit/Study of Financial Institutions: PACS/DCCB, Apex Banks/ RRBs, CBs/ NABARD.

References :

Pandey, U.K. 1990. **An Introduction to Agricultural Finance**, Kalyan Publishers,New Delhi.

Singh, B.P. and Chhabra, T.N., 1984. Revised by U. Chhabra and A.K.Singh, **Essentials of Management**, Kitab Mahal, Allahabad.

Singh, J.P., 1988, **Agricultural Finance Theory and Practices**, Ashish Publishing House, New Delhi.

Nelson and Murray, 1988. Agricultural Finance. Kalyani Publishers, NewDelhi.

Kamat, G.S., 1978, New Dimensions of Cooperative Management, Himalyan Publishing House, Mumbai.

Krishnaswami, O.R., 1978, Fundamentals of Cooperation, S.Chand & Company Ltd., New Delhi.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -221 AGRICULTURAL MARKETING, TRADE AND PRICES Cr. Hrs.2 (1+1)

Theory:

Agricultural Marketing: Meaning, Definition, Scope and Subject Matter. Market: Meaning, Definition, Components of a market, Classification. Marketing Agencies, Marketable surplus and Marketed surplus. Factors Affecting Marketable Surplus. Marketing Channels: Meaning, Definition. Market integration: Meaning, Definition, Types of Market Integration. Marketing Efficiency: Meaning, Definition. Marketing costs, Margins and Price Spread, Factors affecting the Cost of Marketing. Meaning of International Trade, Domestic Trade, Free trade, GATT, WTO and EXIM-policy. Introduction to Cooperative Marketing. State Trading. Central and State Warehousing Corporation; AGMARK. Price: Meaning, Types, Role and Functions. Agricultural Price Policy: Meaning, Objectives and Need. Futures trading. Contract farming.

Practical:

Identification of Marketing Channels; Study of regulated markets and unregulated markets; Study of Vegetable market. Price spread analysis; Visit/ study of SWC/ Cold storage unit; Analysis of information on daily price; Marketed and marketable surplus of different commodities.

References :

1. Acharya, S.S. and Agarwal, N.L., 1994, Agricultural Price Analysis and Price Policy, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Acharya, S.S. and Agarwal, N.L., 2004, Agricultural Marketing in India, Oxford and IBH Publishing Co. New Delhi.
3. Mamoria, C.B and Joshi, R.L., 1971, Principles and Practice of Marketing in India, Kitabmahal, Allahabad.
4. Kahlon, A.S. and George, M.V., 1985, Agricultural Marketing and Price Policy, Allied Publication Pvt. Ltd., New Delhi.
6. vxzoky] ,u- ,y-] 1996] Hkkjrh; Ñf"k dk vFkZrU=] jktLFkku fgUnh xzUFk vdkneh] t;iqj A
5. Kohls, Richard L. and Uhl, Joseph N., 1980, Marketing of Agricultural Products, Macmillan Publishing Co., Inc. New York

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DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -311 FUNDAMENTALS OF AGRI-BUSINESS MANAGEMENT

(Including Project Development, Appraisal and Monitoring)

Cr.Hrs.2(1+1)

Theory

Agribusiness: Meaning, Definition, Structure of Agribusiness (Input, Farm, Product Sectors). Importance of Agribusiness in the Indian Economy. Agribusiness Management: Distinctive features, Importance, Definition of Management, Management Function. Planning: Meaning, Definition, Type of plans (Purpose or Mission, Goals or Objectives, Strategies, Policies, Procedures, Rules, Programmes, Budget). Financial Management of Agribusiness: Importance of Financial Statements, Balance Sheet, Profit and Loss Statement, Analysis of Financial Statements. Agro-based Industries: Importance, Need, Classification of Industries. Marketing Management: Meaning, Definition. Marketing Mix: Basic of marketing mix, 4Ps of Marketing Mix, Market segmentation. Product life cycle. Pricing policy: Meaning and Pricing Method. Project: Definition, Project cycle-Identification, Formulation, Appraisal, Implementation, Monitoring and Evaluation. Appraisal and Evaluation techniques, viz.: NPW, BCR, IRR.

Practical :

Analysis of Financial Statements: Balance Sheet, Profit and Loss Statements; Study/Visit of Financing Institutions-Cooperatives/ Commercial Banks/ RRBs. Preparation of Projects; Feasibility reports; Project appraisal techniques: Computation of NPV, BCR, and IRR, Case Study of Agro-Based Industries. Enlisting of Agro-Based Industries.

Reference :

1. Bhatia, K. L. and Kewal Khanna, **Export Management**, Raj Publishing House, 44 Parnami Mandir, Govind Marg, Jaipur.
2. Adrian Buckley, **Essential of International Money**, Prentice Hall, New Delhi – 110 001.
3. Tink Findle, **The Economist Guide to Management Ideas**, Profile Books Limited, 58 a, Hatton Garden, London.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -321 PRODUCTION ECONOMICS AND FARM MANAGEMENT

Cr. Hr. 2(1+1)

Theory:

Production Economics; Meaning, Definition, Nature and Scope of Agricultural Production Economics. Basic Concepts and terms. Concepts of Production. Production Function: Meaning, Definition. Laws of returns: Increasing, Constant and Decreasing. Factor Product Relationships. Factor Factor Relationships. Product Product Relationships. Types of enterprises. Returns to Scale: Meaning, Definition, Importance. Farm Management: Meaning, Definition, Scope. Economic principles applied to the Organisation and Operation of farm business. viz. Principle of Variable Proportion, Cost Principle, Principle of comparative Advantage. Types and systems of farming. Farm Planning and Budgeting. Risk & uncertainty.

Practical:

Computation of cost concepts; Methods of computation of Depreciation; Analysis of Net Worth Statement; Preparation of Farm Plans and Budgets; Preparation of Profit and Loss Account; Break-even Analysis; Application of Farm Management Principles. viz. Principle of Variable Proportion, Cost Principle, Principle of comparative Advantage.

References :

1. Johl, S.S. and T.R. Kapur, 1989, **Fundamentals of Farm Business Management**, Kalyani Publishers, Ludhiyana.
2. Kahlon, A.S. and Karam Singh, 1980, **Economics of Farm Management in India**, Allied Publishers, New Delhi.
3. Sankhayan, P. L., 1988, **Introduction to the Economics and Agricultural Production**, Prentice Hall of India Private Limited, New Delhi.
4. Heady, Earl O and Dillon John L, 1988, **Agricultural Production Function,** Kalyani Publishers, New Delhi.
5. Singh, I. J., 1977, **Elements of Farm Management Economics**, Affiliated East-West Press Pvt. Ltd., New Delhi.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

DESCRIPTION OF COURSES FOR M.Sc. (Ag.Econ.)

Core Courses

AGECON 511 MICRO ECONOMIC THEORY AND APPLICATIONS

Cr.Hrs.3(3+0)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Market Equilibrium - Behavior of Firms in Competitive Markets – Perfect Competition- Effect of Taxation and Subsidies on market equilibrium - Monopoly- Monopolistic – Oligopoly.

UNIT IV

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

Suggested Readings

David M Kreps 1990. ***A Course in Microeconomic Theory***. Princeton University Press.

Dewitt KK. 2002. ***Modern Economic Theory.*** Sultan Chand & Company ltd., New Delhi.

Henderson JM & Quandt RE. 2000. ***Microeconomic Theory: A Mathematical Approach.*** McGraw-Hill, Kogakusha Ltd., New Dlhi.

Koutsoyiannis A. 2003. ***Modern Microeconomics***. The Macmillan Press Ltd., Hampshire.

Silberberg E & Suen W. 2001. ***The Structure of Economics – A Mathematical Analysis***. McGraw-Hill.

Varian Hal R. 1999. ***Intermediate Microeconomics***. Affiliated East-West Press.

Jhingan M.L., 2004. ***Micro Economic Theory***, Vikas Publishing House Pvt. Ltd., New Delhi

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON- 512 MACRO ECONOMICS AND POLICY

Cr. Hrs. 3(3+0)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Suggested Readings

Ahuja HL. 2007. ***Macroeconomics: Theory and Policy***. S. Chand & Company Ltd., New Delhi.Eugene A Diulio 2006. ***Macroeconomics***. 4th Ed. Schaums' Outlines.

Gardner Ackely 1987. ***Macro Economic: Theory and Policy***. Collier Macmillan.

Dornbusch. 2006. ***Macroeconomics***. McGraw Hill Publication, Kogakusha.

Jhingan M.L., 2004. **M*acroeconomic Theory***, Vrinda Publications Pvt. Ltd., New Delhi

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON –513 AGRICULTURAL PRODUCTION ECONOMICS

Cr. Hrs. 3(2+1)

Objective

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

Theory

UNIT I

Nature, scope and significance of agricultural production economics- Agricultural Production processes, character and dimensions-spatial and temporal, assumptions of production functions, commonly used forms - Properties, limitations, specification, estimation and interpretation of commonly used production functions.

UNIT II

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

UNIT III

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

UNIT IV

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

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.

Suggested Readings

Beattie BR & Taylor CR. 1985. ***The Economics of Production***. John Wiley & Sons.

Doll JP & Frank O. 1978. ***Production Economics - Theory and Applications***. John Wiley & Sons.

Gardner BL & Rausser GC. 2001. ***Handbook of Agricultural Economics***. Vol. I. *Agricultural Production*. Elsevier.

Heady EO. ***Economics of Agricultural Production and Resource Use***. Prentice-Hall.

Sankayan PL. 1983. ***Introduction to Farm Management***. Tata Mc Graw Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON –521 AGRICULTURAL MARKETING AND PRICE ANALYSIS Cr.Hrs.3(2+1)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

Practical

Supply and demand elasticity in relation to problems in agricultural marketing. Price spread and marketing efficiency analysis. Performance analysis of Regulated market and marketing societies. Analysis on contract farming and supply chain management of different agricultural commodities, milk and poultry products. Chain Analysis - quantitative estimation of supply chain efficiency - Market Intelligence – Characters, Accessibility, and Availability Price forecasting. Online searches for market information sources and interpretation of market intelligence reports.

Suggested Readings

Purecell WD & Koontz SR. 1999**.** ***Agricultural Futures and Options: Principles and Strategies***. 2nd Ed. Prentice-Hall.

Rhodes VJ. 1978. ***The Agricultural Marketing System***. Grid Publ., Ohio.

Shepherd SG & Gene AF. 1982. ***Marketing Farm Products***. Iowa State Univ. Press.

Singhal AK. 1986. ***Agricultural Marketing in India***. Annual Publ., New Delhi.

OPTIONAL COURSES

AGECON- 522 RESEARCH METHODOLOGY FOR SOCIAL SCIENCES Cr.Hrs.3(2+1)

Objective

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

Theory

UNIT I

Importance and scope of research in agricultural economics. Types of research - Fundamental vs. Applied. Concept of researchable problem – research prioritization – selection of research problem. Approach to research – research process.

UNIT II

Data collection – assessment of data needs – sources of data collection – discussion of different situations. Mailed questionnaire and interview schedule – structured, unstructured, open ended and closed-ended questions. Scaling Techniques. Preparation of schedule – problems in measurement of variables in agriculture.

Interviewing techniques and field problems - methods of conducting survey – Reconnaissance survey and Pre testing.

UNIT III

Sampling theory and sampling design – sampling error - methods of sampling – probability and non-probability sampling methods - criteria to choose. Research design and techniques – Types of research design.

UNIT IV

Hypothesis – meaning - characteristics - types of hypothesis – review of literature – setting of Course Objective and hypotheses - testing of hypothesis.

UNIT V

Preparing research report / thesis – Universal procedures for preparation of bibliography – writing of research articles.

Practical

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

Suggested Readings

Black TR. 1993. ***Evaluating Social Science Research - An Introduction.*** SAGE Publ.

Creswell JW. 1999. ***Research Design - Qualitative and Quantitative Approaches.*** SAGE Publ.

Dhondyal SP. 1997. ***Research Methodology in Social Sciences and Essentials of Thesis Writing***. Amman Publ. House, New Delhi.

Kothari CR. 2004. ***Research Methodology - Methods and Techniques.*** Wishwa Prakashan, Chennai.

Rao KV. 1993. ***Research Methodology in Commerce and Management.*** Sterling Publ., New Delhi.

Singh AK. 1993. ***Tests, Measurements and Research Methods in Behavioural Sciences.*** Tata McGraw-Hill.

Venkatasubramanian V. 1999. *Introduction* ***to Research Methodology in Agricultural and Biological Sciences***. SAGE Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -523 ECONOMETRICS

Cr.Hrs. 3(2+1)

Objective

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

Theory

UNIT I

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

UNIT II

Basic two variable regression - assumptions estimation and interpretation approaches to estimation – OLS and their properties, 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, specification, estimation and interpretation.

UNIT V

Simultaneous equation models, 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.

Suggested Readings

Gujarati DN. 2003. ***Basic Econometrics***. McGraw Hill.

Johnson AG Jr., Johnson MB & Buse RC. 1990. ***Econometrics - Basic and Applied.*** MacMillan.

Kelejan HH & Oates WE. 1994.***Introduction to Econometrics Principles and Applications.*** Harper and Row Publ.
Koutsoyianis A. 1997. ***Theory of Econometrics***. Barner & Noble.
Maddala GS. 1992. ***Introduction to Econometrics***. MacMillan.
Maddala GS. 1997***. Econometrics.*** McGraw Hill.
Pindyck RS & Rubinfeld DL. 1990. ***Econometrics Models and Econometric Forecasts***. McGraw Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -524 LINEAR PROGRAMMING

Cr.Hrs. 3(2+1)

Objective

The Course Objective of the course is to impart knowledge of Linear programming techniques.

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 farm problems as linear programming models and solutions.

UNIT III

Extension of Linear Programming models.

UNIT IV

Game Theory- Concepts of game theory, two person constant sum, zero sum game, saddle point, solution to mixed strategies.

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.

Suggested Readings

Dorfman R. 1996. ***Linear Programming & Economic Analysis***. McGraw Hill.
Loomba NP.2006. ***Linear Programming***. Tata McGraw Hill.
Shenoy G. 1989. ***Linear Programming-Principles & Applications***. Wiley Eastern Publ.

Vaserstein. 2006. ***Introduction to Linear Programming***. Pearson Education Publication

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DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON-531 AGRICULTURAL FINANCE AND PROJECT MANAGEMENT

Cr.Hrs.3(2+1)

Objective

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

Theory

UNIT I

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.

UNIT III

Preparation of financial statements - Balance Sheet, Cash Flow Statement and Profit and Loss Account. Ratio Analysis and Assessing the performance of farm/firm.

UNIT IV

Identification, preparation, appraisal, financing and implementation of projects. Project Appraisal techniques – Undiscounted measures. Time value of money – Use of discounted measures - B-C ratio, NPV and IRR. Agreements, supervision, monitoring and evaluation phases in appraising agricultural investment projects. Net work Techniques – PERT and CPM.

UNIT V

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

Practical

Rural Lending Programmes of Commercial Banks, Lead Bank Scheme Co-operative Lending Institutions, Preparation of financial statements using farm/firm level data, Farm credit appraisal techniques and farm financial analysis through financial statements, Performance of Micro Financing Institutions - NGO's and Self-Help Groups, Project appraisal techniques – Undiscounted Measures and their limitations. Project appraisal techniques – Discounted Measures, Network techniques – PERT and CPM for project management, Case Study Analysis of an Agricultural project, Financial instruments and methods – E banking, Kisan Cards and core banking.

Suggested Readings

Dhubashi PR. 1986. ***Policy and Performance - Agricultural and Rural Development in Post Independent India***. Sage Publ.

Gittinger JP 1982. ***Economic Analysis of Agricultural Projects*.** The Johns Hopkins Univ. Press.

Gupta SC. 1987. ***Development Banking for Rural Development***. Deep & Deep Publ.

Little IMD & Mirlees JA. 1974. ***Project Appraisal and Planning for Developing Countries*.** Oxford & IBH Publ.

Muniraj R. 1987. ***Farm Finance for Development***. Oxford & IBH Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON 532 :AGRICULTURAL DEVELOPMENT AND POLICIES

Cr.Hrs 3(3+0)

Objectives

• To provide orientation to the students regarding the concepts and measures of economic development

• To provide orientation on theories of economic growth and relevance of theories in developing countries.

• To make them to understand the agricultural policies and its effect on sustainable agricultural development

• To make them to understand the globalization and its impact on agricultural development.

Theory

UNIT I

Development Economics – Scope and Importance - Economic development and economic growth - divergence in concept and approach - Indicators and Measurement of Economic Development – GNP as a measure of economic growth – New Measures of Welfare. Criteria for under development – Obstacles to economic development – Economic and Non-Economic factors of economic growth.

UNIT II

Economic development – meaning, stages of economic development, determinants of economic growth. Theories of economic growth – Ricardian growth model – The Harrod – Domar Model – Marxian model, Schumpeter model, Lewis model. Role of state in economic development – Government measures to promote economic development. Introduction to development planning.

UNIT III

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

UNIT IV

Development issues, poverty, inequality, unemployment and environmental degradation – Models of Agricultural Development - 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.

Suggested Readings

Chakaravathi RM. 1986. ***Under Development and Choices in Agriculture***. Heritage Publ., New Delhi.

Diwett KK. 2002**.** ***Modern Economic*** *Theory***.** S. Chand & Co.

Eicher KC & Staatz JM. 1998. ***International Agricultural Development***. Johns Hopkins Univ. Press.

Frank E. 1992. ***Agricultural Polices in Developing Countries***. Cambridge Univ. Press.

Ghatak S & Ingersent K. 1984. ***Agriculture and Economic Development***. Select Book Service Syndicate, New Delhi.

Jhingan ML. 1998. ***The Economics of Development and Planning***. Vrinda Publ.

Jules PN. 1995. ***Regenerating Agriculture – Polices and Practice for Sustainability and Self Reliance***. Vikas Publ. House.

Naqvi SNH. 2002. ***Development Economics – Nature and Significance***. Sage Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON-533 NATURAL RESOURCE AND ENVIRONMENTAL ECONOMICS

Cr.Hrs.3(2+1)

Objectives

• To introduce economics principles related to natural resource and environmental economics

• To explore the concept of efficiency and the efficient allocation of natural resources

• To understand the economics of why environmental problems occur.

• To explore the concept of efficiency and the efficient allocation of pollution control and pollution prevention decisions.

• To understand the environmental policy issues and alternative instruments of environmental policies

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

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

UNIT VI

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

Practical

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

Suggested Readings

Ahmad Y, El Serafy S & Lutz E. (Eds.). 1989.**Environmental Accounting for Sustainable Development**. World Bank.

Freeman AM. 1993. ***The Measurement of Environmental and Resource Values***. Resources for the Future Press, Baltimore.

Hackett SC. 2001. ***Environmental and Natural Resource Economics: Theory, Policy, and the Sustainable Society***. M. E. Sharpe, Armonk, NY.

Hartwick JM & Olewiler ND. 1998. ***The Economics of Natural Resource Use***. 2nd Ed. Addison-Wesley Educational Publ.

Kerr JM, Marothia DK, Katar Singh, Ramasamy C & Bentley WR. 1997. ***Natural Resource Economics: Theory and Applications in India.*** Oxford & IBH.

Kolstad CD. 2000. **Environmental Economics**. Oxford Univ. Press.

Pearce DW & Turner K. 1990. ***Economics of Natural Resources and the Environment***. John Hopkins Univ. Press.

Prato T. 1998. ***Natural Resource and Environmental Economics***. Iowa State Univ. Press.

Sankar U. 2001. **Environmental Economics**. Oxford Univ. Press.

Sengupta R. 2000. ***Ecology and Economy, an Indian Perspective***. Oxford Univ. Press.

Tietenberg T. 2003. ***Environmental and Natural Resource Economics***. 6th Ed. Addison Wesley.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON-534 INTERNATIONAL ECONOMICS

Cr.Hrs. 3(2+1)

Objective

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

Theory

UNIT I

Scope and Significance of International Economics - The role of trade- General Equilibrium in a Closed Economy (Autarky Equilibrium) – Equilibrium in a

Simple Open Economy - Possibility of World Trade - Trade gains and Trade Equilibrium.

UNIT II

Tariff, Producer Subsidy, Export Subsidy, Import Quota and Export Voluntary Restraints- The Case of Small Country and Large Country Case.

UNIT III

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.

UNIT V

IMF, World Bank, IDA, IFC, ADB – International Trade agreements – Uruguay Round – GATT – WTO.

Practical

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

Suggested Readings

Apple Yard DR & Field AJ Jr. 1995. ***International Economics - Trade, Theory and Policy.*** Irwin, Chicago.

Cherunilam F. 1998. ***International Economics***. Tata McGraw Hill.

Krugman PR & Obstfeld M. 2000. ***International Economics – Theory and Policy***. Addison-Wesley.

AGECON- 535 EVOLUTION OF ECONOMIC THOUGHT

Cr.Hrs.3(3+0)

Objective

To introduce the students to the evolution of economic thought over a period of time, the background of emanation of thoughts and approaches, as acts of balancing and counter balancing events and criticisms. The course will also in a

comprehensive way help the students to know and appreciate the contributions of the Galaxy of Economists.

Theory

UNIT 1

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

UNIT II

Development of Classical Thoughts (Adam Smith, Robert Malthus and David Ricardo) – Critics of Classical Thoughts- Socialist critics – Socialist and Marxian Economic Ideas – Origins of Formal Microeconomic Analysis.

UNIT III

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

UNIT IV

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.

UNIT V

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.

Suggested Readings

Blaug M. 1964. ***Economic Theory in Retrospect***. Heineman.

Blaug M. 1986. ***Economic History and the History of Economic Thought***. Wheatsheaf Books, Brighton.

Ekelund RB & Hebert RF. 1975. ***A History of Economic Theory and Methods.*** McGraw-Hill.

John Mills A. 2002. ***Critical History of Economics: Missed Opportunities***. Palgrave Macmillan.

Screpanti E & Zamagni S. 1995. ***An Outline of the History of Economic Thought***. Clarendon Press, Oxford.

DESCRIPTION OF COURSES FOR Ph.D.

<u>CORE COURSES</u>

AGECON- 611 ADVANCED MICRO ECONOMIC ANALYSIS

Cr.Hrs.3(3+0)

Objectives

The Course Objective of this course is to introduce the theoretical models and applications of microeconomic theory. In particular, the basic comparative statistical techniques and the more modern duality theory will be developed and applied to the models of maximization, unconstrained and constrained utility maximization, expenditure minimization, constrained profit maximization, and cost and expenditure minimization. These mathematical structures form the basic building blocks of neoclassical economics; this course will stress the development and application of these important models. We follow a calculus rather than a graphical approach to the theory. In the subsequent sections of the course, we provide a fairly rigorous exposure to price determination under different market situations, general equilibrium theory, causes and consequences of market failure and welfare economics including the theory of public choice.

Theory

UNIT I

Theory of consumer behaviour – Duality in consumer theory – expenditure function and indirect utility function - Measurement of Income Effect and Substitution Effect. Measurement of Changes in Consumers' Welfare – Consumer's Surplus, Compensating Variation and Equivalent Variation - Dynamic versions of demand functions – Integrability of demand functions. Demand Models – Linear Expenditure System.

UNIT II

Perfect competition – Monopoly, monopolistic competition and oligopoly. Oligopoly models – collusive and non-collusive models of oligopoly - Cournot model & Chamberlin model.

UNIT III

General equilibrium theory – Conceptual overview - General equilibrium conditions with Production and Consumption. Existence, Uniqueness and Stability of general competitive equilibrium.

UNIT IV

Market failure - Incomplete markets - Asymmetric information – Principal- Agent problem, adverse selection and moral hazard. Externalities – Network externalities - Public goods – Optimal provision of public goods.

UNIT V

Welfare Economics - Concepts, problems, approaches and limitations of Welfare Economics, Pareto conditions of maximum welfare – Criteria for social welfare - Social Welfare functions, Social versus Private costs and benefits.
2

Suggested Readings

Chiang AC. 1981. ***Fundamental Methods of Mathematical Economics***. McGraw-Hill.

Henderson JM & Quandt RE. ***Microeconomic Theory: A Mathematical Approach***. McGraw-Hill.

Koutsoyiannis A. 2003. **Modern Microeconomics**. The Macmillan Press.

Kreps DM. 1990. ***A Course in Microeconomic Theory***. Princeton Univ.Press.

Silberberg E & Suen W. 2001. ***The Structure of Economics – A Mathematical Analysis***. McGraw-Hill.

Varian HR. 1992. ***Microeconomic Analysis***. WW Norton & Co.

Varian HR. 1999. ***Intermediate Microeconomics***. Affiliated East-West Press.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON- 613 ADVANCED PRODUCTION ECONOMICS

Cr.Hrs.3(2+1)

Objective

To expose the students to the concept, significance and uses of advance production economics.

Theory

UNIT I

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

UNIT II

Production functions, components, assumptions, properties and their economic interpretation - Concepts of homogeneity, homotheticity, APP, MPP, elasticities of substitution and their economic relevance – Production relations –optimality- Commonly used functional forms, nature, properties, limitations, estimation and interpretation -linear, Spillman -Cobb Douglas, quadratic, multiplicative (power) functional forms, transcendental functional forms -CES, production functional forms- Conceptual and empirical issues in specification, estimation and application

of production functions- Analytical approaches to economic optimum -Economic optimum with production function analysis - input use behaviour.

UNIT III

Decision making with multiple inputs and outputs – MRT and product relationship-cost of production and adjustment in output prices-single input and multiple product decisions- Principles and derivation of demand and supply functions

UNIT IV

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

UNIT V

Simulation and programming techniques in agricultural production.

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- Estimation of factor shares from empirical functions estimated: Decomposition analysis. Simulation models for agricultural production decisions.

Suggested Readings

Chambers RG. 1988. ***Applied Production Analysis.*** Cambridge Univ. Press.

Gardner BL & Rausser GC. 2001. ***Handbook of Agricultural Economics***. Vol. IA *Agricultural Production.* Elsevier.

Palanisami KP, Paramasivam & Ranganathan CR. 2002. ***Agricultural Production Economics: Analytical Methods and Applications.*** Associated Publishing Co.

OPTIONAL COURSES

AGECON-612 ADVANCED AGRICULTURAL MARKETING AND PRICE ANALYSIS Cr.Hrs. 3(2+1)

Objective

The main Course Objective of this course is to critically analyze the important marketing concepts, models, properties of agricultural commodity prices and forecasting, data collection and analysis using current software etc., in order to make them policy decisions in the field of agricultural marketing.

Theory

UNIT I

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

UNIT II

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

UNIT III

Multi market estimation, supply response models. Market integration and price transmission - supply / value chain management. GAP analysis. Current trends in information in the changing agrifood system.

UNIT IV

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

UNIT V

Lag operators and difference equations; stationary and stochastic processes; UNIT roots and cointegration; conditional heteroscedasticity: ARCH and GARCH models - forecast

evaluation; methods of forecasting. price indices and econometric estimation and simulation.

Practical

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

Suggested Readings

Ferris JN. 1998. ***Agricultural Prices and Commodity Market Analysis***. McGraw-Hill.

Goodwin JW. 1994. ***Agricultural Price Analysis and Forecasting***. Wiley.

Hallam D. 1990. ***Econometric Modeling of Agricultural Commodity Markets***. New Routledge.

Martimort D. (Ed.). 1996. ***Agricultural Markets: Mechanisms, Failures, and Regulations*****. Elsevier.**

Schrimper RA. 2001. ***Economics of Agricultural Markets***. Pearson.

Timmer CP. 1986. ***Getting Prices Right.*** Cornell University Press.

Tomek WG & Robinson KL. 2003. ***Agricultural Product Prices***. 4th Ed. Cornell University Press.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -614 ADVANCED ECONOMETRICS

Cr.Hrs. 3(2+1)

Objective

The Course Objective of the course is to impart knowledge on advanced econometric tools to the Research Scholars of agricultural economics. Training in advanced econometrics will help the Research Scholars to analyze the economic problem by applying quantitative techniques.

Theory

UNIT I

Review of classical regression model – review of hypothesis testing – restrictions on parameters – single equation techniques.

UNIT II

Ordinary least squares – weighted least squares - generalized least squares – method of principal components – instrumental variables method - maximum likelihood method - errors in variables.

UNIT III

Dummy variables - Qualitative and truncated dependent variables – limited dependent variables –LPM, probit and logit models.

UNIT IV

Autoregressive distributed lag models – panel data fixed and random effects models.

UNIT V

Simultaneous equation methods –identification & estimation.

Practical

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

Suggested Readings

Greene WH. 2002. ***Econometric Analysis***. Pearson Edu.

Johnston J & Dinardo J. 2000. ***Econometric Methods***. McGraw-Hill.

Kelejan HH & Oates WE. 2001. ***Introduction to Econometrics Principles and Applications.*** Harper & Row.

Maddala GS. 2002. *Econometrics.* McGraw Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON- 621 ADVANCED MACRO ECONOMICS ANALYSIS

Cr.Hrs. 3(3+0)

Objective

Advanced macroeconomics course will be offered to PhD students of

Agricultural Economics with the following Course Objective.

- To understand the macroeconomic theory
- To examine the macroeconomic Policy issues
- To analyze the macroeconomic Policy implications

Theory

UNIT I

Review of Macro Economics concepts-Comparative statistics- Keynesian theory-Consumption Function and Theories of Consumption –Saving Function and Theories of Saving.

UNIT II

Theories of Investment-Savings and Investment Equality - IS – LM Framework and its mand for and Supply of Money-Monetary Policy in the static model – Inflation.

UNIT III

Stagflation and Supply side Economics - Theory of Unemployment - Phillips Curve controversy - Inflation, Productivity and distribution – Fiscal policy: Effectiveness and Problems.

UNIT IV

Social Accounting Matrix Framework - General Equilibrium Analysis - Neo classical Macro Economics - Stochastic Macro Economics.

UNIT V

BOP & Adjustment Policies - Foreign Exchange Policy - Foreign sector : Capital and Current Account - Impact of WTO on Indian Economy - Impact of IMF & IBRD on Indian Economy - Review of Macro Economic Policies in India.

Suggested Readings

Diulio EA. 2006. ***Macroeconomics.*** 4th Ed. Schaums' Outlines.

Frogen RT. 1999. ***Macro Economic: Theory and Policies***. 6th Ed. Prentice Hall.

Samuelson PA & Nordhaus WD. 2004. ***Economics.*** **McGraw-Hill**.

Shapiro E. 1989. **Macro Economic Analysis**. Galgotia Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -622 NATURAL RESOURCE MANAGEMENT

Cr.Hrs.3(2+1)

Objectives

This is an applied economics course that focuses on the economic analysis of natural resources, and seeks to identify and solve natural resource management problems via mathematical approach using dynamic optimization techniques. During the course, we will encounter bioeconomic models of natural resources including the classic and more recent forestry and fisheries models, models of land and water use and extraction of non-renewable resources (such as from a mineral

deposit). We will focus on intuition and understanding of the economic analysis rather than complicated mathematical models in this class. That said, natural resource problems are inherently dynamic, so some mathematical modeling of biophysical and economic processes will be required. Using computers as an aid to understanding the models will be an important part of the class.

The primary tool will be Microsoft Excel, which is the easiest introduction to computational optimization and graphical representation of the results.

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.

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.

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 groundwater and forestry resource.

UNIT V

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

Practical

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

Suggested Readings

Baland J-M & Platteau JP. 1996. ***Halting Degradation of Natural Resources: Is There a Role for Rural Communities?*** Clarendon Press and FAO.

Carlson GA, Miranowski J & Zilberman D. 1998. ***Agricultural and Environmental Resource Economics.*** Oxford Univ. Press.

Chiang AC. 1992. ***Elements of Dynamic Optimization***. Waveland Press.

Clark CW. 1976. ***Mathematical Bioeconomics: The Optimal Management of Renewable Resources***. John Wiley and Sons.

Conrad JM & Clark CW. 1997. ***Natural Resource Economics: Notes and Problems***. Cambridge Univ. Press.

Conrad JM. 1999. ***Resource Economics***. Cambridge University Press.

Fisher AC. 1981. ***Resource and Environmental Economics***. Cambridge Univ. Press.

Prato T. 1998. ***Natural Resource and Environmental Economics***. Iowa State Univ. Press.

Sterner T. 2003. **Policy Instruments for Environmental and Natural Resource Management**. Resources for the Future, Washington DC.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON- 623 COMMODITY FUTURES TRADING

Cr.Hrs.3(3+0)

Objective

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

Theory

UNIT I

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

UNIT II

Transaction and settlement – delivery mechanism - role of different agents - trading strategies - potential impact of interest rate, Foreign Exchange, FDI in Commodity Markets.

UNIT III

Risk in commodity trading, importance and need for risk management measures - managing market price risk: hedging, speculation, arbitrage, swaps - pricing and their features.

UNIT IV

Important global and Indian commodity exchanges - contracts traded – special features -Regulation of Indian commodity exchanges - FMC and its role.

UNIT V

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

Suggested Readings

(i) Kaufman PJ**.** *1986.* ***The Concise Handbook of Futures Markets***. John Wiley & Sons.

(ii) Leuthold RM, Junkus JC & Cordier JE. 1989. ***The Theory and Practice of Futures Markets.*** Lexington Books.

(iii) Lofton T. 1993. ***Getting Started in Futures***. 3rd Ed. John Wiley & Sons.

(iv) Purcell WD. 1991. ***Agricultural Futures and Options: Principles and Strategies.*** Macmillan Publ.

(v) Wasendorf RR & McCafferty. 1993. ***All about Commodities from the Inside Out.*** McGraw-Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

AGECON -624 QUANTITATIVE DEVELOPMENT POLICY ANALYSIS

Cr.Hrs. 3(2+1)

Objective

• The course trains the Scholars in the art of informed decision making and helps them to appreciate the value of the analytical basis in policy decisions.
• They are given hands on training on the estimation and use of various criteria such as elasticities in making QDPA more meaningful
• The scholars make extensive reviews to get acquainted with the analytical relevance and in drawing inferences.

Theory

UNIT I

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

UNIT II

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

UNIT III

Household behaviour and policy analysis – Household models.

UNIT IV

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

UNIT V

Social Accounting Matrices and multipliers.

Practical

Review of criteria for policy evaluation – Estimation of price elasticities – Review of estimation of complete demand systems – Estimation of Nerlovian supply Response model – Review of Household models – Specification and estimation of household models – Partial equilibrium analysis – Input–output table – Social Accounting Matrix.

Suggested Readings

Chenery H & Srinivasan TN. (Eds.). 1988. ***Hand book of Development Economics***. North-Holland.

Eicher KC & Staatz JM. 1998. ***International Agricultural Development***. Johns Hopkins Univ. Press.

Fischer G, Miller J & Sidney MS. (Eds.). 2007. ***Handbook of Public Policy Analysis: Theory, Politics and Methods.*** CRC Press.

Frank E. 1992. ***Agricultural Polices in Developing Countries***. Cambridge Univ. Press.
Ghatak S & Ingersent K. 1984. ***Agriculture and Economic Development***. Select Book Service Syndicate.
Kindleberger PC. 1977. ***Economic Development***. McGraw Hill.
Meier MG & Stigilitz JE. 2001. ***Frontiers of Development Economics- the Future Perspective***. Oxford Univ. Press.
Sadoulet E & de Janvry A. 1995. ***Quantitative Development Policy Analysis***. (London: John Hopkins Univ. Press.
Shoven Neck R, Christian R & Mooslechner P. (Eds.). 2008. ***Quantitative Economic Policy Essays in Honour of Andrew Hughes Hallett.***

DISCRIPTION OF COURSES FOR MBA (Agri-Business)
CORE COURSES

ABM 514 COMMUNICATION FOR MANAGEMENT AND BUSINESS
Cr.Hrs.2(2+0)

Objective

The course aims to make students proficient in written as well oral communication. The focus will be on business related communication.

Contents

UNIT I

Introduction to communication, Communication process, Barriers to Communication, Effective Communication, types of communication in organisations viz. Downward, Upward, Horizontal, Static Vs dynamic.

UNIT II

Non-Verbal Communication, Communication through clothes/ colours / space/ symbol, Body language and etiquettes, Interpersonal Communication, Self-concept and communication, Assertive Communication.

UNIT III

Types of business writing viz, News letters, Reports, Folders, Fact Sheets, Press release; Readership and writing style - human aspects of writing.

UNIT IV

Meetings - Planning for meeting, tips for chairing, opening, progress & ending, Behavior of ordinary members, the character of business meeting, Energies for meetings, Group discussions, brain storming sessions and presentations.

UNIT V

Handling personal communication - Letters, dictation, reading, problem-solving, listening skills, self-talk, self - reflection, steps to personal creativity, public speaking.

Suggested Readings

Bovee. 2008. ***Business Communication Today.*** 7th Ed. Pearson Edu.

Brown L. 2006. ***Communication Facts and Ideas in Business***. Prentice Hall.

Lesikar. 2004. ***Basic Business Communication***. McGraw Hill.

Ramchandran KK, Lakshmi KK & Karthik KK. 2007. ***Business Communication.*** Macmillan.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 515 HUMAN RESOURCE MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The objective of this course is to expose the learner to the field of human resource management. The focus will be on human resource practices and their utility for managers.

Contents

UNIT I

Introduction to Human Resources Management; Human Resource Planning-Nature and Significance, Job Analysis, Job Description, job Specification, Job enlargement, Job enrichment, Job rotation, Job evaluation.

UNIT II

Recruitment and Selection Process, Induction, Training and Human Resource Development-Nature, Significance, Process and Techniques, Internal mobility including Transfers, Promotions, employee separation.

UNIT III

Performance Appraisal – Significance and methods, Compensation management, Wage and Salary Administration - Course Objective; Wage Fixation; Fringe Benefits, Incentive Payment, bonus, and Profit Sharing.

UNIT IV

Industrial Relations-Role and Status of Trade Unions; Collective Bargaining; Worker's Participation in Management, Career planning and employee retention.

UNIT V

Quality of work life, employee welfare measure, Disputes and grievance Handling Procedures; Arbitration and Adjudication; Health and Safety of Human Resources; Human Resources accounting, Human Resources outsourcing.

Suggested Readings

Ashwathapa K. 1997. ***Human Resource Management***. Tata McGraw.

Flippo EB. 1984. ***Personnel, Management***. McGraw-Hill.

Garry D. 2001. ***Human Resource Management***. 7th Ed. Prentice-Hall of India.

Mamoria CB. 1996. ***Personnel Management***. Himalaya Publ. House.

Subba Rao P. 2004. ***Essentials of Human Resource Management and Industrial Relations.*** Himalaya Publ. House.

Venkantavatnam CS & Srivastav BK. 1991. ***Personnel Management and Human Resources.*** Tata McGraw-Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 516 MARKETING MANAGEMENT

Cr.Hrs.3(3+0)

Objective

The objective of this course is to develop an understanding of the field of marketing. The focus will be on imparting knowledge of the basic concepts, tools, and functions of marketing.

Contents

UNIT I

The Concept of Marketing Management; Marketing Environment; Marketing Mix, Strategic Marketing, Market Segmentation, Targeting, and Positioning; Buyer Behavior, Marketing Information System, Marketing Organization and Control.

UNIT II

Marketing potential and forecasting, Classification of Products; Product Life Cycle; New Product Development; Product Line and Product Mix; Branding, Packaging and labeling.

UNIT III

Factors affecting prices; Pricing Policies and Strategies; Pricing Methods.

UNIT IV

Types of Distribution Channels; Functions of Channel Members; Channel Management Decisions.

UNIT V

Promotion Mix; Introduction to Advertising, Personal Selling, Sales Promotion, Publicity and Public Relations. and Direct marketing, managing integrated marketing promotion, Customer Relationship Management.

Suggested Readings

Brassington 1997. ***Marketing Management.*** Pitman Publ. House.

Kotler P. 2002. ***Marketing Management – Analysis, Planning, Implementation and Control.*** Pearson Edu.McCarthy 2003. ***Marketing Management.*** Tata

McGraw-Hill.Saxena R. 2002. ***Marketing Management.*** Mc Graw Hill.Stanton WJ, Etzel MJ & Walker BJ. 1996. ***Fundamentals of Marketing***. McGraw- Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 522 FINANCIAL MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The course aims to make students proficient in concepts and techniques of financial management. Focus will be on developing understanding of the application of Financial and investment decisions.

Contents

UNIT I

Introduction to Financial Management**,** Its meaning and functions, Interface of financial management with other functional areas of a business. Financial Statements and Analysis - Proforma Balance Sheet and Income Statements, ratio, time series, common size and Du-Pont analysis.

UNIT II

Capital Structure, Determinants of size and composition of Capital Structure, Capital Structure Theories; Long term financing and Cost of Capital.

UNIT III

Working Capital Management, Determinants of Size and Composition of Working Capital, Cash and receivables management, Working Capital Management Theories, Financing of Working Capital.

UNIT IV

Financial planning and Forecasting, Financial planning for mergers & acquisition, Capital Budgeting**,** Undiscounted and Discounted cash flow methods of Investment Appraisal; Hybrid finance and lease finance.

UNIT V

Business Financing System in India, Money and Capital Markets, Regional and All - India Financial Institutions; venture capital financing and its stages, micro finance and International financial management.

Suggested Readings

Chandra P. 2000. ***Financial Management***. Tata McGraw Hill.
Khan MY & Jain PK. 2004. ***Financial Management: Text, Problems and Cases***. Tata McGraw Hill.
Pandey IM. 1997. ***Financial Management***. Vikas Publ.
Ramachandran N & Kakani RK. 2005. ***Financial Accounting for Management***. Tata McGraw Hill.
Van Horne JC. 1997. ***Financial Management and Policy***. Prentice Hall.

COMPLASORY COURSES

ABM 511 PRINCIPLES OF MANAGEMENT AND ORGANIZATIONAL BEHAVIOUR

Cr.Hrs.3(3+0)

Objective

To acquaint the learner with meaning and concepts of management and organizational behaviour. Focus will be on understanding the concepts, processes, significance, and role of management and organizational behaviour.

Contents

UNIT I

Nature, Scope and Significance of Management, Evolution of Management Thought, Approaches to Management, Functions of a Manager, Planning - Types, Steps, Course Objective, Process, Strategies, Policies, MBO, Strategic Planning Process, SWOT analysis, Organizing – Structure & Process, Line Staff, Authority & responsibility.

UNIT II

Staffing – Selection process, Directing – Training, Communication & motivation, Controlling- Significance, Process, Techniques, Standards & Benchmarks, Management Audit.

UNIT III

Nature, Scope and Significance of Organizational Behavior; Evolution and Historical Background of Organizational Behavior; Models of Organizational Behaviour Foundations of individual behaviour, Diversity, Micro Organizational behavior - Personality, self-concept, self-esteem and Self-Efficacy; Attitudes, Perception, Power – types & structures.

UNIT IV

Motivation- Types of motivation. Theories of motivation, Applications of motivation. Transactional analysis-Johari window-self fulfilling prophecy,

Interpersonal relations-understanding, determinants, and developing; leadership styles and influence process; leadership theories; types of leaders, and effective leader; group dynamics, types of groups, group formation, Group decision making, Team Building.

UNIT V

Organizational culture or climate-concept, dimensions, ethos, determinants; organizational conflicts-concepts, sources, implications, and management; organizational changes - types, resistances to change, role of change agents.

Suggested Readings

Fred Luthans 1998. ***Organizational Behavior***. Tata McGraw Hill.

Harold Koontz & Keing Weig

hhrich. ***Essentials of Management***. McGraw Hill.

John W Newstrom & Keith Davis. 1997. ***Human Behaviour at Work***. Tata McGraw.

Robert C Appleby. 1997. ***Modern Business Administration***. Macmillan India.

Stephen P Robbins 2007. ***Organizational Behaviour***. Prentice Hall.

Stoner James AF. 2005. ***Management***. Pearson Edu.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 512 AGRIBUSINESS ENVIRONMENT AND POLICY

Cr.Hrs.2(2+0)

Objective

To expose learners to the environment in which the agri-business is conducted. Focus will be on understanding micro and macro environmental forces and their impact on agri-business.

Contents

UNIT I

Role of agriculture in Indian economy; problems and policy changes relating to farm supplies, farm production, agro processing, agricultural marketing, agricultural finance etc. in the country.

UNIT II

Structure of Agriculture - Linkages among sub-sectors of the Agribusiness sector; economic reforms and Indian agriculture; impact of liberalization, privatization and globalization on Agri business sector.

UNIT III

Emerging trends in production, processing, marketing and exports; policy controls and regulations relating to the industrial sector with specific reference to agroindustries.

UNIT IV

Agribusiness policies- concept and formulation; and new dimensions in Agribusiness environment and policy.

UNIT V

Agricultural price and marketing policies; public distribution system and other policies.

Suggested Readings

Adhikary M. 1986. ***Economic Environment of Business***. S. Chand & Sons.
Aswathappa K. 1997. ***Essentials of Business Environment***. Himalaya Publ.
Francis Cherunilam 2003. ***Business Environment***. Himalaya Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 513 MANAGERIAL ECONOMICS

Cr.Hrs.3(3+0)

Objective

To familiarize the students with the fundamental economic concepts and principles in the context of managerial decision making.

Contents

UNIT I

Scope of managerial economics, objective of the firm and basic economic principles; mathematical concepts used in managerial economics.

UNIT II

Demand analysis - meaning, types and determinants of demand; demand function; demand elasticity; demand forecasting-need and techniques.

UNIT III

Production, cost and supply analysis- production function, least-cost input combination, factor productivities and returns to scale, cost concepts, cost-output relationship, short and long-run supply functions.

UNIT IV

Pricing-determinants of price - pricing under different market structures, pricing of joint products, pricing methods in practice, government policies and pricing.

UNIT V

The national income; circular flow of income: consumption, investment and saving: money-functions, demand & supply; inflation; economic growth; business cycles and business policies; business decisions under uncertainty.

Suggested Readings

Baumol WJ. 1980. ***Economic Theory and Operations Analysis***. Prentice Hall of India.

Craig PH & Chris LW. 1996. ***Managerial Economics***. Prentice Hall of India.

Dernberg TF. *et. al.* 1986. ***Macro Economics: Concepts, Theories and Policies.*** McGraw Hill.

Dwivedi DN. 2002. ***Managerial Economics***. Vikash Publ.

Gupta GS. 1997. ***Managerial Economics.*** Tata McGraw Hill.

Koutsoyiannis A. 1989. ***Modern Micro Economics.*** Mac Millan Press.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 518 MANAGERIAL ACCOUNTING AND CONTROL

Cr.Hrs.2(1+1)

Objective

The objective of this course is to expose the learner to the concept and methods of financial and management accounting. Focus will be on understanding techniques, uses and applications of financial and management accounting.

Contents

UNIT I

Financial Accounting- Meaning, Need, Concepts and Conventions; Branches of Accounting, Internal and External Users of Accounting, Advantages and Limitations of Financial Accounting, Accounting Standards.

UNIT II

The Double Entry System- Its Meaning and Scope, The Journal, Cash Book, Ledger, Trial Balance, Trading Account, Profit and Loss Account, Balance Sheet, Entries and Adjustments of different heads in different Books and Accounts. Introduction of Company Accounts.

UNIT III

Managing Accounting-Meaning, Functions, Scope, Utility, Limitations and Tools of Management Accounting, Analysis of Financial Statements- Ratios, Comparative and Common Size Statements, Cash Flow and Funds Flow Analysis, Management Audit and Financial.

UNIT IV

Cost Accounting – Nature, Course Objective, Significance of Cost Accounting; Classification of Cost, Costing for Material, Labour, and Overheads; Marginal Costing and cost volume profit Analysis- Its Significance, Uses and Limitations; Standard Costing – Its Meaning, Uses and Limitations; Determination of Standard Cost, Variance Analysis- Material, Labour and Overhead.

UNIT V

Responsibility Accounting- Its Meaning and Significance, Cost, Profit and Investment Centres, Accounting for Price Level Changes- Concepts, CPP and CCA Methods. Budget and Budgetary Control- Its Meaning, Uses and Limitations, Budgeting and Profit Planning, Different Types of Budgets and their Preparations, Sales Budget, Purchase Budget, Production Budget, Cash Budget, Flexible Budget, Master Budget, Zero Based Budgeting.

Suggested Readings

Horngren. 2008. ***Introduction to Financial Accounting*.** 8th Ed. Pearson Edu.

Khan MY & Jain PK. 2004. ***Management Accounting***. Tata McGraw Hill.

Maheshwari SN & Maheshwari SK. 2003. ***Financial Accounting***. 3rd Ed. Vikas Publ. House.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 521 BUSINESS LAWS AND ETHICS

Cr.Hrs.2(2+0)

Objective

The objective of this course is to expose the learner to various ethical issues and laws affecting business. Focus will be on understanding provisions of various business laws and also ethical practices to conduct the business properly.

Contents

UNIT I

Introduction to Indian legal system, The Indian Contract Act-1872: Contract meaning, nature, significance, types of contract, essentials of a valid contract, offer and acceptance, capacity to contract, free consent, performance of contract.

UNIT II

Companies Act-1956: incorporation, commencement of business, types of companies, management, winding of companies, Negotiable Instruments Act.

UNIT III

Essential Commodities Act, APMC Act, Consumer Protection Act, RTI Act, MRTP Act- major provisions and implications.

UNIT IV

Factory Act, Labour laws, Industrial dispute Act.

UNIT V

Nature and importance of ethics and moral standards; corporations and social responsibilities, scope and purpose of business ethics; Ethics in business functional areas; industrial espionage; solving ethical problems; governance mechanism.

Suggested Readings

Gulshan SS & Kapoor GK. 2003. ***Business Law including Company Law***. 10th Ed.
New Age Publ.
Kapoor ND. 2005. ***Business Law***. S. Chand & Sons.
Tulsain PC. 2006 . ***Business Law***. Tata McGraw Hill.
Tuteja SK. 2005. ***Business Law for Managers.*** S. Chand & Sons.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 523 PRODUCTION AND OPERATIONS MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The objective of this course is to expose the learner to the field of production and operations management. The focus will be on imparting knowledge of the basic concepts, tools, and functions of production management.

Contents

UNIT I

Nature and Scope of Production and Operations Management; Its relationship with Other Systems in the Organization; Factors Affecting System and Concept of

Production and Operation Management; Facility location, Types of Manufacturing Systems and Layouts, Layout Planning and Analysis.

UNIT II

Productivity Variables and Productivity Measurement, Production Planning and Control, Mass Production, Batch Production, Job Order Manufacturing, Product Selection, Product Design and Development, Process Selection, Capacity planning.

UNIT III

Scheduling, Maintenance Management Concepts, Work Study, Method Study, Work Measurement, Work Sampling, Work Environment, Industrial Safety,

UNIT IV

An Overview of Material Management, Determination of Material Requirement, Purchase Management, Store Management, Logistics management, Material Planning and Inventory management, JIT, Safety Management .

UNIT V

Quality Assurance, Accepting Sampling, Statistical Process Control, Total Quality Management, ISO standards and their Importance, Introduction to re-engineering, value engineering.

Suggested Readings

Adam & Ebert. 2006. ***Production and Operations Management: Concepts, Models and Behaviour.*** 5th Ed. Prentice Hall of India.

Buffa ES. 2008. ***Modern Production/Operations Management***. Wiley India.

Stevenson WJ. 2005. ***Operations Management***. Tata McGraw Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 524 RESEARCH METHODOLOGY IN BUSINESS MANAGEMENT

Cr.Hrs.2(1+1)

Objective

The objective of this course is to develop an understanding of research methodology. The focus will be on process and techniques of research.

Contents

UNIT I

Meaning, Course Objective, types, and process of research; research methodology in management- exploratory, descriptive, experimental, diagnostic, Problem formulation, setting of Course Objective, formulation of hypotheses.

UNIT II

Scales of measurement - nominal, ordinal, interval, ratio, Likert scale and other scales; Primary and secondary data, sources of data, instruments of data collection, data editing, classification, coding, validation, tabulation, presentation, analysis.

UNIT III

Concept of Sampling, Probability and non-probability sampling techniques including Simple Random Sampling, Stratified Sampling, Multi-stage Sampling, Systematic ampling, Purposive Sampling, Quota sampling, judgment sampling, and convenience sampling, sample size determination, sampling and non-sampling errors.

UNIT IV

Role and uses of quantitative techniques in business decision making, Use of Equations, Use of Determinants and Matrices in business decisions, Frequency Distribution, Measures of Central Tendency, Measures of Variation, Skewness and Kurtosis, Simple, partial, and multiple correlation, rank correlation, simple and multiple regression, Discriminant and dummy variable analysis.

UNIT V

Index Numbers, Hypothesis testing, ANOVA, Factor analysis, cluster analysis, conjoint analysis, multi-dimensional analysis etc, Report writing: Types of report, essentials and contents of good report writing.

Suggested Readings

Cooper DR & Schindler PS. 2006. ***Marketing Research Concepts and Cases***. Tata McGraw Hill.

Green PE, Tull DS & Albaum G. 1998. ***Research for Marketing Decisions.*** Prentice Hall of India.

Kothari CR. 1989. ***Research Methodology***. Wiley Eastern.

Wilkinson & Bhandarker 1989. ***Research Methods in Social Sciences***. Himalaya Publ. House.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 526 PROJECT MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

Cr.Hrs.3(3+0)

Objective

The objective of this course is to expose the learner to the fields of project management and entrepreneurship development. Focus will be to train the students to develop new projects and encouraging them to start their own ventures.

Contents

UNIT I

Concept, characteristics of projects, types of projects, project identification, and Project's life cycle.

UNIT II

Project feasibility- market feasibility, technical feasibility, financial feasibility, and economic feasibility, social cost-benefit analysis, project risk analysis.

UNIT III

Network Methods: Meaning, Network Analysis, Requirements for Network Analysis, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Project scheduling and resource allocation.

UNIT IV

Financial appraisal/evaluation techniques- discounted/non-discounted cash flows; Net present values, profitability index, Internal rate of returns; Cost benefits ratio; Accounting rate of return, Pay back period, Project implementation; Cost over run, Project control and information system.

UNIT V

Entrepreneurship, Significance of entrepreneurship in economic development qualities of entrepreneur, entrepreneurship development programs and role of various institutions in developing entrepreneurship, life cycles of new business, environmental factors affecting success of a new business, reasons for the failure and visible problems for business, Developing effective business plans, Procedural steps in setting up of an industry.

Suggested Readings

Chandra P. 2005. ***Project Management***. Tata McGraw Hill.

Gopal Krishan P & Nagarajan K. 2005. ***Project Management***. New Age.

Hisrich RD & Peters MP. 2002. ***Entrepreneurship***. Tata McGraw Hill.

Kaplan JM. 2003. ***Patterns of Entrepreneurship***. John Wiley & Sons.

Nandan H. 2007. ***Fundamentals of Entrepreneurship Management***. Prentice Hall.

Ramamoorthy VE. 2005. ***Textbook of Project Management***. MacMillan.

OPTIONAL COURSES

ABG 531 AGRICULTURAL MARKETING MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The objective of this course is to give the students an understanding of concept, various policies, strategies and decisions relating to marketing that can be developed by agribusiness firms.

Contents

UNIT I

Meaning and scope, agricultural marketing and economic development; Agricultural market structure – meaning, components and dynamics of market structure; marketing strategy – meaning & significance, formulation of marketing strategy; agribusiness marketing environment, design of marketing mix, market segmentation and targeting, determinants of consumer's behaviour.

UNIT II

Product management - product management process and decisions, new product development – significance and classification of new product, stages and estimation of demand of new product; product life cycle.

UNIT III

Pricing policies and practice for agribusiness - determinants of price, objectives of pricing policies and pricing methods.

UNIT IV

Promotional management - advertising planning and execution; sales promotion; grading and standardization.

UNIT V

Distribution management - storage and warehousing and transportation management for agricultural products; marketing agencies/intermediaries – roles and functions; distribution channels involved in agribusiness.

UNIT VI

Case studies

Suggested Readings

Acharya SS & Agarwal NL. 2004. ***Agricultural Marketing in India***. 4th Ed. Oxford & IBH.
Kohls RL & Uhj JN. 2005. ***Marketing of Agricultural Products***. 9th Ed. Prentice Hall.
Kotler P. 2002. ***Marketing Management – Analysis, Planning, Implementation and Control.*** Pearson Edu.
Krishnamacharyulu C & Ramakrishan L. 2002. ***Rural Marketing***. Pearson Edu.
Ramaswamy VS & Nanakumari S. 2002. ***Marketing Management***. 2nd Ed. Mac Millan India.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 532 FARM BUSINESS MANAGEMENT

Cr.Hrs.2(2+0)

Objective

To acquaint the students with the basic principles of farm management dealing with the analysis of farm resources having alternatives within the framework of resource restrictions.

Contents

UNIT I

Nature, scope, characteristics and role of farm business management; farm management decisions; farm management problems.

UNIT II

Principles of farm management decisions – principle of variable proportion, cost principle, principle of factor substitution, law of equi-marginal returns, opportunity cost principle, etc.

UNIT III

Tools of farm management and farm business analysis - farm planning and budgeting; Farm records and accounts, types and problems in farm records and accounts, net worth statement, farm efficiency measures.

UNIT IV

Management of farm resources – Land, Labour, Farm machinery, Farm building, etc.

UNIT V

Risk and uncertainty in farming -sources of uncertainty in farming, management strategy to counteract uncertainty and decision making process in farm business management under risks and uncertainty.

Suggested Readings

Heady EO & Jensen H. 1960. ***Farm Management Economics***. Prentice Hall.

Johl SS & Kapoor TR. 1973. ***Fundamentals of Farm Business Management***. Kalyani Publ.

Kahlon AS & Singh K. 1992. ***Economics of Farm Management in India.*** Allied Publ.

Panda SC. 2007. ***Farm Management & Agricultural Marketing***. Kalyani Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 533: AGRICULTURAL RISK MANAGEMENT Cr.Hr.2 (2+0)

Objective: To provide an understanding of different types of risks involved in agribusiness and strategies to manage them

Contents

UNIT I

Concept and meaning of agricultural risk; Variate and non-covarite risk. Risk Management for farmers: Types of risks – price risk, yield risk, climate and weather risk, asset risk, health risk, etc;

UNIT II

Impact of climate change and weather aberrations on crop yield and socio-economic status with special reference to arid regions.

UNIT III

Strategies for agricultural risk management: Designing, products and programmes for combating risk. Estimation of losses. Risk avoidance and mitigation; Agricultural insurance, compensation, legislative and regulatory mechanism.

Suggested Readings

(i) Dana L Hoag, *Applied risk Management in Agriculture*.

(ii) Peter J. Barry, *Risk Management in Agriculture.*
(iii) Ramaswami Bharat, *Risk Management in Agriculture.*
(iv) Bomin, Christopher A., *Agricultural Options: Trading, Risk and Hedging.*
(v) Ravi and Kishor, *Risk Management.*

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 534: MICRO-FINANCE MANAGEMENT Cr.Hr.2 (2+0)

Objective: The course aims at equipping the students with desired skills and understanding about financial needs for small scale agribusiness and development activities

Contents

UNIT I
Micro-finance: An overview of the fast growing industry; status and trends.

UNIT II
Portfolio and delinquency management. Pricing of micro-finance products; applicable interest rates and sustainability.

UNIT III
Important aspects and strategic issues for developing a business plan. Project formulation related to a micro enterprise for financial support, its economic feasibility and repayment plan.

UNIT IV
Need for micro saving services, micro insurance, micro credit and self-help groups. Overview of micro financing agencies in India and role of RBI, NABARD, commercial banks in providing financial support for small scale projects related to agribusiness and rural development.

UNIT V
Micro-finance standards, subsidy dependence and sustainability, legal aspects of microfinance. MIS for micro-finance.

UNIT VI
Case studies.

Suggested Readings

(i) Ghate Prabhu, Sai Gunaranjan and Vijay Mahajan.*Micro Finance in India* : A state of the sector report, 2007.
(ii) Panda K Debadutta, *Understanding Microfinance*
(iii) Karmakar K.G., *Microfinance in India.*
(iv) Armendariz Beatriz, *Handbook of Microfinance.*

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 535: COMMODITY MARKETS AND FUTURES TRADING

Cr.Hr.2 (2+0)

Objective: To understand the marketing procedure for commodity futures through commodity exchanges

Contents

UNIT I
Introduction to commodity derivatives and price risk management in agricultural markets; organizational setup of exchanges and specifications of futures contracts in world's leading commodity exchanges

UNIT II
Mechanics of futures trading; hedging price risk using futures contracts; option transaction and forward transaction – concept and mechanism, price discovery mechanism and market efficiency

UNIT III
Clearinghouse and margin system; clearing, settlement and delivery of contracts

UNIT IV
Market surveillance and risk control; trading in warehouse receipts (WRs): WRs and collateralized commodity financing

UNIT V
Regulation of futures and trading practices in leading national and regional exchanges in India.

Suggested Readings

Sridhar A.N., *Future and Options*
Bala S.D., *Strafegic Financial Management*
Gupta S.L., *Financial Derivatives*

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 536 : BANKING & INSURANCE MANAGEMENT
Cr.Hr.2 (2+0)

Objective : This course aims at developing an understanding of the banking system and insurance with special reference to agriculture sector.

Contents

UNIT I
Financial Intermediation, Indian Financial system, Origin and Growth of Banking. RBI and its functions. Principles of Banking, Banking Law and Practice. Nationalization of Banks in India, Deposit Products, Lending Activities, Retail Banking, Wealth Management, Financing SMEs, Corporate Banking, Forex Management, Fee-Based & Subsidiary Services, Plastic Money, Role of Central Banks, Emerging Trends in Banking, Fundamentals of International Banking.
UNIT II
Introduction of Marketing, Understanding Services, Distinctive Aspects of Service Marketing, Strategies Issues in Bank Marketing, Positioning Bank Services in the Market, New Product Development, Pricing and Launching, New Distribution Channels for Bank Marketing, Communicating and Promoting Bank Services,

Improving Quality and Productivity, Customer Relationship Management in Banks, Globalizing Bank Services, Opportunities and Challenges in Bank Marketing.

UNIT III

Credit Policy in Banks, Principles of Credit Management, Objectives of Credit Management, Credit Disbursal and Monitoring, Credit Deployment and Types of Borrowers, Follow up and Recovery Management, Treasury Operations, Introduction to Risk Management in Banks, Rural Banking in India, Security Considerations, Control System in Banks, Corporate Governance in Banks, Annual Reports and Statutory Audit.

UNIT IV

Introduction to Banking Operations, Front Office and Back Office Operations, Operational Controls, Demand Forecasting and Resource Allocation, Policy Framing – Deposits, Advances and Investments, Services Design and Delivery Strategies in Banks, Service Quality Metrics, Work Measurement and Quality Assurance, Payment and Settlement Systems, RTGS and Clearing House, Cash Management Services, Facilities Planning, ERP in Banks, BPR in Banks, IT Enabled Supply Chain Management, Disaster and Recovery Management.

UNIT V

Introduction to Risk, Risk Management Essentials, Measurement of Risk, Loss Exposure, Risk Management – Non-insurance Techniques, Introduction to Insurance, Principles of Insurance, Insurance Industry, Insurance Market, Insurance as Risk Management Techniques, Selection and Implementation of Risk Management Techniques.

Suggested Readings

Gordon and Natarajan, *Banking Theory, Law and Practise.*

Iyengar Vijayaragawan, *Introduction to Banking*

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 537 AGRI SUPPLY CHAIN MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The course introduces students to the concepts and processes of agricultural supply chain management, framework for structuring supply chain drivers; network designs, demand forecasting, inventory planning, sourcing decisions and IT enablement of supply chain.

Contents

UNIT I

Supply Chain: Changing Business Environment; SCM: Present Need; Conceptual Model of Supply Chain Management; Evolution of SCM; SCM Approach; Traditional Agri. Supply Chain Management Approach; Modern Supply Chain Management Approach; Elements in SCM.

UNIT II

Demand Management in Supply Chain**:** Types of Demand, Demand Planning and Forecasting; Operations Management in Supply Chain, Basic Principles of Manufacturing Management.

UNIT III

Procurement Management in Agri. Supply chain: Purchasing Cycle, Types of Purchases, Contract/Corporate Farming, Classification of Purchases Goods or Services, Traditional Inventory Management, Material Requirements Planning, Just in Time (JIT), Vendor Managed Inventory (VMI).

UNIT IV

Logistics Management: History and Evolution of Logistics; Elements of Logistics; Management; Distribution Management, Distribution Strategies; Pool Distribution; Transportation Management; Fleet Management; Service Innovation; Warehousing; Packaging for Logistics, Third-Party Logistics (TPL/3PL); GPS Technology.

UNIT V

Concept of Information Technology: IT Application in SCM; Advanced Planning and Scheduling; SCM in Electronic Business; Role of Knowledge in SCM; Performance Measurement and Controls in Agri. Supply Chain Management-Benchmarking: introduction, concept and forms of Benchmarking.

Suggested Readings

Altekar RV. 2006. ***Supply Chain Management: Concepts and Cases***. Prentice Hall of India.

Monczka R, Trent R & Handfield R. 2002. ***Purchasing and Supply Chain Management***. Thomson Asia.
Van Weele AJ. 2000. ***Purchasing and Supply Chain Management Analysis,Planning and Practice***. Vikas Publ. House.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 538 RURAL MARKETING

Cr.Hrs.2(2+0)

Objective

To objective of this course is to develop understanding regarding issues in rural markets like marketing environment, consumer behaviour, distribution channels, marketing strategies, etc.

Contents

UNIT I

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

UNIT II

Environmental factors - socio-cultural, economic, demographic, technological 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, customer relationship management, rural market research.

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, distribution strategy.

UNIT V

Promotion and communication strategy - Media planning, planning of distribution channels, and organizing personal selling in rural market in India, innovation in rural marketing.

Suggested Readings

Krishnamacharyulu C & Ramakrishan L. 2002. ***Rural Marketing***. Pearson Edu.

Ramaswamy VS & Nanakumari S. 2006. ***Marketing Management***. 3rd Ed. MacMillan Publ.

Singh AK & Pandey S. 2005. ***Rural Marketing***. New Age.

Singh Sukhpal. 2004. ***Rural Marketing***. Vikas Publ. House.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABG 539 INTERNATIONAL TRADE AND SUSTAINABILITY GOVERNANCE

Cr.Hrs.2(2+0)

Objective

To impart knowledge to the students of international trade in agriculture and various provisions under WTO in the new trade regime.

Contents

UNIT I

International trade – basic concepts, WTO and its implications for Indian economy in general and agriculture sector in particular.

UNIT II

TRIPS, TRIMS quotas, anti dumping duties, quantitative and qualitative restrictions, tariff and non-tariff measures, trade liberalization, subsidies, green and red boxes, issues for negotiations in future in WTO; CDMs and carbon trade.

UNIT III

Importance of foreign trade for developing economy; absolute and comparative advantage, foreign trade of India.

UNIT IV

Composition of India's foreign trade policy; India's balance of payments; inter regional Vs international trade; tariffs and trade control; exchange rate; the foreign trade multiplier.

UNIT V

Foreign demand, supply side analysis, opportunity cost, trade and factor prices, implications for developing countries, market entry methods, export procedures & documentations.

Suggestive Readings

Chadha GK. 2003. ***WTO and Indian Economy***. Deep & Deep.

Economic Survey of India. Ministry of Finance, Govt. of India. (various issues)

HAU 2003. ***Refresher Course on Technological Interventions to Face WTO Challenges***. AAREM & HRD CCS HAU Hisar.

Indian Journal of Agricultural Economics

Vasisht AK & Singh Alka. 2003. ***WTO and New International Trade Regime-Implication for Indian Agriculture***. Advance Publ. Concept.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 531 MANAGEMENT OF AGRICULTURAL INPUT MARKETING

Cr.Hrs.2(2+0)

Objective

The objective of this course is to give the students an understanding of different marketing concept and marketing system in context of agricultural inputs.

Contents

UNIT I

Agricultural input marketing – meaning and importance; Management of distribution channels for agricultural input marketing; Agricultural Inputs and their types – farm and non-farm, role of cooperative, public and private sectors in agriinput marketing.

UNIT II

Seed- Importance of seed input; Types of seeds- hybrid, high yielding and quality seeds; Demand and supply of seeds; Seed marketing channels, pricing, exportimport of seeds; Role of NSC and State Seed Corporation.

UNIT III

Chemical Fertilizers- Production, export-import, supply of chemical fertilizers, Demand/consumption, Prices and pricing policy; subsidy on fertilizers; marketing

system – marketing channels, problems in distribution; Role of IFFCO and KRIBCO in fertilizer marketing.

UNIT IV

Plant Protection Chemicals- Production, export/import, consumption, marketing system – marketing channels; Electricity/Diesel Oil- marketing and distribution system; pricing of electricity for agriculture use; subsidy on electricity.

UNIT V

Farm Machinery- Production, supply, demand, Marketing and distribution channels of farm machines; Agro-industries Corporation and marketing of farm machines / implements/Equipments.

Suggested Readings

Acharya S.S. & N.L.Agarwal, 2004. ***Agricultural Marketing in India***. 4th Ed. Oxford & IBH.

Broadway AC & Broadway Arif A. 2003. ***A Text Book of Agri-Business Management***. Kalyani.

Singh AK & Pandey S. 2005. ***Rural Marketing.*** New Age.

Singh Sukhpal 2004. ***Rural Marketing- Focus on Agricultural Inputs***. Vikas Publ.

House.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 532 FERTILIZER TECHNOLOGY AND MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The objective of this course is to acquaint the students in latest advances in fertilizer technology management.

Contents

UNIT I

Fertilizer development – concept, scope, need, resource availability; import and export avenues for fertilizer; types of fertilizers, grading and chemical constituents, role of fertilizers in agricultural production, production and consumption of fertilizer in India.

UNIT II

Raw material needed and principles of manufacturing of nitrogenous, phosphatic and potassic fertilizers, secondary nutrient sources and micro-nutrient formulations.

UNIT III

Production efficiency and capacity utilization; quality control and legal aspects fertilizer control order.

UNIT IV

Testing facilities; constraints in fertilizer use and emerging scenario of fertilizer use; assessment of demand and supply of different fertilizers, fertilizer distribution, fertilizer storage.

UNIT V

Field trials and demonstration, fertilizer pricing policy; scope of bio-fertilizer; environmental pollution due to fertilizer use.

Suggested Readings

Brady NC & Weil RR. 2002. ***The Nature and Properties of Soils***. 13th Ed. Pearson Edu.

Fertilizer Control Order **(different years).** Fertilizer Association of India, New Delhi.

Fertilizer Statistics **(different years)**. Fertilizer Association of India, New Delhi

Indian Journal of Fertilizers (different years). Fertilizer Association of India, New

Delhi.

San Chilli V. 1960. ***Chemistry and Technology of Fertilizers***. American Chemical Soc. Monograph Series. Reinhold Publ. Corp.

Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 2002. ***Soil Fertility and Fertilizers.*** 5th Ed. Prentice Hall.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 533 MANAGEMENT OF AGRO CHEMICAL INDUSTRY

Cr.Hrs.2(2+0)

Objective

To familiarize the students with the agrochemicals, their structure, classification and development and also how to manage the agro-chemical industries.

Contents

UNIT I

Agro-chemicals: Definition and classification; Basic knowledge of agrochemicals; role and status of agro-chemical industry in India; Pesticides – Classification and Introduction, knowledge of different pesticides.

UNIT II

Insecticides – Definition and classification based on (a) Mode of Entry (b) Mode of Action and (c) Chemical Structure with example; Insecticidal formulation; preliminary knowledge of mode of action of insecticides; knowledge of plant protection equipments.

UNIT III

Fungicides – Classification and preliminary knowledge of commonly used fungicides; Biomagnifications of pesticides and pesticidal pollution.

UNIT IV

Introductory knowledge about development of agro-chemicals; Insecticidal poisoning, symptoms and treatment; Main features of Insecticide Act.

UNIT V

Directorate of Plant Protection, Quarantine and Storage – A brief account of its organizational set up and functions; IPM Concept – Bio-pesticides – Plant products.

Suggested Readings

Dhaliwal GS, Singh R & Chhillar BS. 2006. ***Essentials of Agricultural Entomology.*** Kalyani.

Hayes WT & Laws ET. 1991. ***Hand Book of Pesticides***. Academic Press.

Matsumura F. 1985. ***Toxicology of Insecticides***. 2nd Ed. Plenum Publ.

Rajeev K & Mukherjee RC. 1996. ***Role of Plant Quarantine in IPM*.** Aditya Books.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 534 FRUIT & VEGETABLES PRODUCTION AND POST HARVEST MANAGEMENT

Cr.Hrs.2(2+0)

Objective : To impart knowledge regarding agro-techniques of fruit crops and their postharvest management.

Contents

UNIT I

World production and horticulture in India; present status of horticulture industry in India and emerging scenario.

UNIT II

Management of horticultural crops – basic cultural practices, regulation of flowering, fruiting and thinning, protection against insect pest, weeds: pre and post harvest management for quality and shelf life. Protected cultivation in vegetable production management, vegetable production for export purpose, potential and constraints.

UNIT III

Post harvest management in fruits and vegetables- procurement management, important factors for marketing, standardization and quality control, packaging.

UNIT IV

Post harvest management in horticulture- development of fruit-based carbonated drinks, development of dehydrated products from some important fruits, storage of pulp in pouches, essential oils from fruit waste, dehydrated fruits. Market structure and export potential of fruits.

UNIT V

Problems in marketing of fruits and vegetables, and government policy; quality standards for domestic and international trade.

Suggested Readings

Chadha KL & Pareek OP. 1993. ***Advances in Horticulture***. Vols. I-IV. Malhotra Publ. House.

Kader AA. 1992. ***Post-harvest Technology of Horticultural Crops***. Univ. of California. Div. of Agri. & Natural Resources.

Chadha KL & Choudhary B. ***Ornamental Horticulture in India***. ICAR.
Grindal EW. ***Every Day Gardening in India***. D.B. Tarporevala Sons.
Randhawa GS & Mukhopadhyay **A *Floriculture in India***. Allied Publ.
Randhawa MS. ***Beautifying India***. Raj Kamal Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 535 MANAGEMENT OF FLORICULTURE AND LANDSCAPING

Cr.Hrs.2(2+0)

Objective

To objective of this course is to expose the students with floriculture technology and its Agri business implications including international trade.

Contents

UNIT I

Introduction, importance and scope of floriculture industry; Recent advances in floriculture industry.

UNIT II

Evolution of new cultivars; and production technology of ornamental plants; special techniques for forcing of flowers for export.

UNIT III

Drying and dehydration of flowers; response of flowers to environmental conditions; importance and scope of landscape gardening.

UNIT IV

Style of gardening, Anesthetic and Socio-aesthetic planning of old and newly developed towns and cities; commercial cultivation of flower crops (rose, jasmine gladiolus, tuberose, marigold, aster, carnation, gerbera, cilium chrysanthemum; use of plant regulators in flower production.

UNIT V

Extraction, purification and storage of essential oils and perfumes; post harvest changes in cut flowers, storage and packing of cut flowers; determining optimum time of harvesting of flowers for export and home use.

Suggested Readings

Chadha KL & Choudhary B. ***Ornamental Horticulture in India***. ICAR.
Grindal EW. ***Every Day Gardening in India***. D.B. Tarporevala Sons.
Randhawa GS & Mukhopadhyay **A *Floriculture in India***. Allied Publ.
Randhawa MS. ***Beautifying India***. Raj Kamal Publ.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 536 FOOD TECHNOLOGY AND PROCESSING MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The objective of this course is to acquaint the students with different food processing techniques and their management.

Contents

UNIT I

Present status of food industry in India; Organization in food industry; Introduction to operations of food industry; Deteriorative factors and hazards during processing, storage, handling and distribution.

UNIT II

Basic principles of food processing and food preservation by manipulation of parameters and factors and application of energy, radiations, chemicals and biotechnological agents; Packaging of foods.

UNIT III

Analysis of costs in food organization; Risk management; Laws and regulations related to food industry and food production and marketing; Quality management – quality standards, PFA, ISO, etc.

UNIT IV

Case studies on project formulation in various types of food industries – milk and dairy products, cereal milling, oil-seed and pulse milling, sugarcane milling, honey production, baking, confectionery, oil and fat processing, fruits and vegetable storage and handling, processing of fruits and vegetables, egg, poultry, fish and meat handling and processing, etc.

Suggested Readings

Acharya SS & Aggarwal NL. 2004. ***Agricultural Marketing in India***. Oxford & IBH.

Early R. 1995. ***Guide to Quality Management Systems for Food Industries***. Blackie.
Jelen P. 1985. ***Introduction to Food Processing***. Reston Publishing.
Potly VH & Mulky MJ. 1993. ***Food Processing***. Oxford & IBH.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 537 FOOD RETAIL MANAGEMENT

Cr.Hrs.2(2+0)

Objective

The objective of this course is to assist students in understanding the structure and working of food marketing system in India, to examine how the system affects farmers, consumers and middlemen and to illustrate the response of this dynamic marketing system to technological, socio-cultural, political and economic forces over time.

Contents

UNIT I

Introduction to International Food market, India's Competitive Position in World Food Trade, Foreign Investment in Global Food Industry, Retail management and Food Retailing, The Nature of Change in Retailing, Organized Retailing in India, E-tailing and Understanding food preference of Indian Consumer, Food consumption and Expenditure pattern, Demographic and Psychographic factors affecting Food Pattern of Indian Consumer.

UNIT II

Value Chain in Food Retailing**,** Principal trends in food wholesaling and retailing, food wholesaling, food retailing, the changing nature of food stores, various retailing formats, competition and pricing in food retailing, market implications of new retail developments, value chain and value additions across the chain in food retail, food service marketing.

UNIT III

4 P's in Food Retail Management**,** Brand Management in Retailing, Merchandise pricing, Pricing Strategies used in conventional and non-conventional food retailing, Public distribution system, Promotion mix for food retailing, Management of sales promotion and Publicity, Advertisement Strategies for food retailers.

UNIT IV

Managing Retail Operations**,** Managing Retailers' Finances, Merchandise buying and handling, Merchandise Pricing, Logistics, procurement of Food products and Handling Transportation of Food Products.

UNIT V

Retail Sales Management Types of Retail Selling, Salesperson selection, Salesperson training, Evaluation and Monitoring, Customer Relationship Management, Managing Human Resources in retailing, Legal and Ethical issues in Retailing.

Suggested Readings

Berman & Evans. 2008. ***Retail Management: A Strategic Approach***. 10th Ed. Prentice Hall of India.

Cox. 2006. *Retailing:* ***An Introduction***. 5th Ed. Pearson Edu.

Levy M & Weitz BW. 2004. ***Retailing Management***. 5th Ed. McGraw Hill.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 538 FARM POWER & MACHINERY MANAGEMENT

Cr.Hrs.2(2+0)

Objective

To acquaint the students with the farm mechanization status in the country and various techniques for farm machinery management and marketing.

Contents

UNIT I

Various sources of farm power, their availability and utilization; Course Objective, importance and present status, level and the scope of farm mechanization.

UNIT II

Tractor and power tillage industry – model, make, capacity, production, present status and future prospects; concept of zero tillage.

UNIT III

Farm machinery selection for different size of farm size and for different agroclimatic conditions; scheduling of farm operations for higher efficiencies, indices of machine performance.

UNIT IV

Cost analysis of operations using different implements, economic performance of machines, optimization of tractor implements system and transport of farm produce.

UNIT V

Agricultural equipments industry – their production, marketing and constraints; establishment of agricultural engineering enterprises (agro service centers, etc.).

Suggested Readings

Carville LA. 1980. ***Selecting Farm Machinery***. Louisiana Coop. Extn. Service Publ.

FAO 1984. ***Agricultural Engineering in Development:*** *Selection of Mechanization*. Agric. Service Bull.

Hunt D. 1977. ***Farm Power and Machinery Management***. Iowa State Univ. Press.

Waters WK. 1980. ***Farm Machinery Management Guide***. Pennsylvania Agric.Extn. Service Spl. Circular No. 1992.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABI 539 FEED BUSINESS MANAGEMENT

Cr.Hrs.2(2+0)

Objective

To acquaint the students with the role and importance of feed industry and the production of feed for livestock and poultry.

Contents

UNIT I

Present status of feed resources; gap between demand and availability of nutrients; status of feed industry in India and world, constraints in the development of Indian feed industry.

UNIT II

Nutrients requirements of livestock and poultry; feed stuff and their origin; scientific storage of feeds and feed ingredients; protection of protein and fat.

UNIT III

Processing of feeds, layout and design of feed plants, feed plant management; feed preparation for fish and pet animals, specialty feeds.

UNIT IV

Importance and preparation of mineral mixture; feed additives and supplements, feed mixing, principles of mixing and compounding of feeds; improving the feeding value of poor quality roughages.

UNIT V

Distribution channels, regulations relating to manufacture and sale of feed stuffs.

Suggested Readings

Gohl BO. 1981. ***Tropical Feeds***. FAO.

McEllihnery Robert R. 1994. ***Feed Manufacturing Technology***. American Feed Industry Assoc.

Pfost Harry B. 1976. ***Feed Manufacturing Technology***. American Feed Industry Assoc.

Rajgopalan K. ***Feed Industry Red Book***. ZMAG Publication.

Rajgopalan K. 1989. ***Storage Structures***. Oxford & IBH.

BASIC SUPPORTING COURSES

ABM 517 COMPUTERS FOR MANAGERS

Cr.Hrs.2(1+1)

Objective

The course objective is to acquaint the students with the knowledge and use of computers and simple applications of computers in managerial decisions. Effort will also be made to provide them an orientation about the increasing role of computers in corporate/business world.

Contents

UNIT I

Concept of Computers- Brief History of Computers, Generation and Its Evolution, Characteristics of Computers, Hardware and Software, introduction to computer languages, Main Areas of Computers and their Applications; Types of Computers – Analog, Digital, Hybrid, General Purpose and Special Purpose Computers, Micro Computers, Mini-Computers, Main-frame Computers, and Super Computers.

UNIT II

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.

UNIT III

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

Suggested Readings

Lucas. 2004. ***Information Technology for Management***. McGraw Hill.

Norton P. 1998. ***Introduction to Computers***. 2nd Ed. Tata McGraw Hill.

Rajaraman V. 2006. ***Introduction to Information Technology***. Prentice Hall of India.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 528 MANAGEMENT INFORMATION SYSTEMS

Cr.Hrs.2(1+1)

Objective

The objective of this course is to develop an understanding and utility of MIS. The focus will be on imparting knowledge of the basic concepts, development, functions and usage of MIS.

Contents

UNIT I

The concept of MIS – Definition, importance, Course Objective, pre-requisites, advantages and challenges; Information Needs of organization, MIS and Decision – Making.

UNIT II

Types/Classification of Information System for organizations - Office Automation Systems, Transaction Processing Systems, Decision Support System, Executive Support System, Knowledge Based Expert System.

UNIT III

Applications of MIS in the areas of Human Resource Management, Financial Management, Production/Operations Management, Materials Management, Marketing Management.

UNIT IV

Development of MIS for an organization – The concept and stages of System Development Life Cycle.

UNIT V

Information Technology– concept, applications, advantages and pre-requisites, Choice of Information Technology, Social and Legal Dimension of IT.

Suggested Readings

James O'Brien 1999. ***Management Information System***. Tata McGraw-Hill.
Lauden & Lauden. 2003. ***Management Information System***. Pearson Edu.

DEPARTMENT OF AGRICULTURAL ECONOMICS AND MANAGEMENT

ABM 529 OPERATIONS RESEARCH

Cr.Hrs.2(1+1)

Objective

The objective of this course is to acquaint the learner with the applications of some important Operations Research techniques. Focus will be on understanding the use of these techniques in solving business problems.

Contents

UNIT I

Linear Programming: Objective, Assumptions, Formulation of Linear Programming Problem, Graphic Method, Simplex method, Transportation and Assignment Problems.

UNIT II

Inventory control Models: Costs Involved in Inventory Management, Types of Inventory, Economic Order Quantity (EOQ) Model, Continuous Review (Q) System, Periodic Review (P) System, Hybrid System, Simulation.

UNIT III

Waiting Line Models: Waiting Line Problem, Characteristics of a Waiting- Line System, Single- Channel Model, Multiple-Channel Model, Constant-Service Time Model, Finite Population Model, Sequencing and Replacement models.

UNIT IV

Decision making under Risk and uncertainties, Decision problem, Maximax Criterion, Maximin Criterion, Minimax Regret Criterion, Laplace Criterion, Pay off Tables, Decision Trees, Expected Value of perfect Information.

UNIT V

Game Theory - Two -Person Zero-Sum Game, Simulation, Network analysis – PERT & CPM.

Suggested Readings

Cook TM & Russell RA. 1989. ***Introduction to Management Science.*** Prentice Hall.

Taha HA. 2005. ***Operations Research - An Introduction***. Prentice Hall.

Vohra ND. 2006. ***Quantitative Techniques in Management***. McGraw Hill.

Wagner HM. 2005. ***Principles of Operation Research***. Prentice Hall.

NON-CREDIT COMPULSORY COURSES

ABN 541 : TECHNICAL WRITING AND COMMUNICATIONS SKILLS – 1(0+1)

Objective : To equip the students with skills for better communication in English language both verbal and written.

Practical

Technical Writing – Various forms of scientific writing- 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, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review ariticle.

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

ABN 542 : LIBRARY AND INFORMATION SERVICES – Non Credit 1 (0 + 1)

Objective: To equip the students with necessary skills for efficient use of the library and information services.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of

information – Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index; Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; e-resources access methods.

DEPARTMENT OF EXTENSION EDUCATION

PROGRAMMES

1. M.Sc.
2. Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of specialization	Development Communication, Human Resource Development, Entrepreneurship Development, e-Extension of Innovation, Gender Sensitization
Core Courses	EXT-511, EXT-512, EXT-513, EXT-521
Optional Courses	EXT-522, EXT-523, EXT-524, EXT-531, EXT-532, EXT-533, EXT-534, EXT-535
Minor & Supporting Courses	STAT-511, STAT-523 or as per decision of advisory committee in view of research problem
Non Credit Compulsory Courses	PGS-502, PGS-503
Deficiency Courses	Nil or as deemed suitable by Advisory Committee

Ph.D.

Field of specialization	Transfer of technology, Organizational development, Media Management, Instructional technology, Training technology
Core Courses	EXT-611, EXT-612
Optional Courses	EXT-613, EXT-614, EXT-621, EXT-622, EXT-623, EXT-624, EXT-625
Minor & Supporting	STAT-611, STAT-624 or as per decision of advisory

Courses	committee in view of research problem
Non Credit Compulsory Courses	PGS-502, PGS-503 (Exempted if done in M.Sc.)
Deficiency Courses	Nil or as deemed suitable by Advisory Committee

DESCRIPTION OF COURES

Undergraduate Courses

EXTED-121 DIMENSIONS OF AGRICULTURAL EXTENSION 2(1+1)

Theory: Education – Meaning, Definition, Types – Formal, Informal and Non-formal education. Extension Education and Agricultural Extension – Meaning, Definition, Concept, Objectives, Principles, Scope and Importance. Development programmes of pre-independence era – Sriniketan, Marthandam, Gurgaon experiment and Gandhian constructive programme with special reference to year of start, objectives and activities. Development programmes of post-independence era - Etawah Pilot project, Community Development Programme – Meaning, Definition, Concepts, Principles, Objectives, Difference between Community Development and Extension Education, National Extension service. Panchayati Raj System / Democratic Decentralization / Three tiers System of Panchayati Raj - Concept, Meaning, Organizational setup and Functions. Agricultural Development Programmes with reference to year of start, objectives & salient features – Institution Village Linkage Programme (IVLP), National Agricultural Technology Project (NATP), ATMA, ATIC & KVK. Poverty Alleviation Programmes – Integrated Rural Development Programme (IRDP), Swarna Jayanti Gram Swarojgar Yojana (SGSY), Prime Minister Employment Yojana (PMEY). Reorganized Extension System (T&V System) – Concept & Methodology.

Practical: Visit to KVK to study their functioning. Visit to Pnchayat Raj Institutions to study the functioning of Gram Panchayat (GP) & Other Institutions. Visit and study the District Rural Development Agency (DRDA). 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.

Suggested Readings:

1) Dhama, O.P. and Bhatanagar, O.P. 1985. Education and Communication for Development, Oxford & IBH Publishing Co., New Delhi.
2) Kelsey, L.D. and Hearne, C.C. 1963. Cooperative Extension Work, Cornell University Press, New York, USA.
3) Ray, G.L. 2003. Extension Communication and Management, Naya Prakash, 206 Bidhan Sarni, Calcutta-6.
4) Reddy, A.A. 1993. Extension Education, Shri Laxmi Press, Baptala.

EXTED-311 FUNDAMENTALS OF RURAL SOCIOLOGY
2(2+0)
AND EDUCATIONAL PSYCHOLOGY

Theory: Sociology and Rural Sociology - Meaning, Definition, Scope, Importance of Rural Sociology in Agricultural Extension and Interrelationship between Rural Sociology & Agricultural Extension. Indian Rural Society, Important characteristics, Differences and Relationship between Rural and Urban societies. Social Groups: Meaning, Definition, Classification, Factors considered in formation and organization of groups. Social Stratification – Meaning, Definition, Functions, Forms of Social stratification. Cultural concepts – Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions – Meaning, Definition and their Role in Agricultural Extension. Social Values and Attitudes – Meaning, Definition, Types and Role of Social Values and Attitudes in Agricultural Extension. Social Institutions – Meaning, Definition, Major institutions in Rural society, Functions. Social Control – Meaning, Definition, Need and Means of Social control. Social change – Meaning, Definition, Nature of Social change and factors of social change. Leadership- Meaning, Definition, Classification, Roles of Leader, Methods of selection of leaders. Psychology and Educational psychology – Meaning, Definition, Scope and Importance of Education Psychology in Agricultural Extension. Intelligence – Meaning, Definition, Types, Factors affecting intelligence. Personality – Meaning, Definition, Types, Factors influencing the Personality and Role of personality in Agricultural Extension. Teaching – Learning process – Meaning and Definition of Teaching, Learning, Learning experience and Learning situation, Elements of learning situation and its characteristics.

Suggested Readings:

1) Bhatia, H.R. 1965. A Text Book of Educational Psychology, Asia Publishing House, New Delhi.

2) Chitamber, J.B. 1990. Introductory Rural Sociology, Wiley Easter Ltd., New Delhi.
3) Desai, A.R. 1953. Rural Sociology in India, Vora & Co. Publisher Pvt.Ltd., Bombay.
4) Dhama, O.P. and Bhatanagar, O.P. 1985. Education & Communication for Development, Oxford & IBH Publishing Co., New Delhi.
5) Pujari, D. 2002. Educational Psychology in Agriculture, Agrotech Publishing Academy, Udaipur(Raj.)-313001.

EXTED-321 EXTENSION METHODOLOGIES FOR TRANSFER OF AGRICULTURAL TECHNOLOGY 2(1+1)

Theory: Communication – Meaning, Definition, Models, Elements and their Characteristics, Barriers in communication. Extension Programme Planning – Meaning, Definition of Planning, Programme, Project, Principles and Steps in Programme Planning. Extension Teaching methods – Meaning, Definition and Classification. Individual contact methods – Farm and Home visit, Telephone call, E.mail. Group contact methods – Group discussion, Method and Result demonstrations; Small group discussion techniques – Lecture, Panel, Workshop, Syndicate group, Brain Storming, Seminar, Conference and Buzz group. Mass contact Methods – Campaign, Exhibition, Kisan Mela, Radio & Television – Meaning, Importance, Steps, Merits & Demerits. Factors influencing in selection of Extension Teaching Methods. Innovative Information sources – Internet, Cyber Cafes, Video and Tele conferences, Kisan call centers. Diffusion – Meaning, Definition and Elements. Adoption Process - Meaning, Stages, Innivation decision process, Adopter categories and their characteristics, Factors influencing adoption process.

Practical: Organization of Group discussion and Method demonstration. Planning and Writing of scripts for Radio and Television. Preparation of selected audio-visual aids – Charts, Posters, Over Head Projector(OHP) Transparencies, Power Point Slides, Leaflet, Folder, Pamphlet, News Stories and Success Stories. Handling of Public Address Equipment (PAE) System, Still Camera, Video Camera and Liquid Crystal Display (LCD) Projector.

Suggested Readings:

1) Das Gupta, S.1989. Diffusion of Agricultural Innovation in Indian Villages, Wiley Eastern Ltd., New Delhi.
2) Kumar, K.J.2000. Mass Communication in India, Jaico Publishing House, 121 Mahatma Gandhi Road, Mumbai.
3) Mathur, K.B.1994. Communication for Development & Social Change, Allied Publisher Ltd., New Delhi.
4) Rogers, E.M. & Shoemaker, F.F.1971. Communication of Innovation – A Cross cultural Approach, The Free Press, New York.
5) Sandhu, A.S.1993. Text book on Agricultural Communication: Process & Methods, Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi.

EXTED-322 COMMUNICATION SKILLS AND ENTREPRENEURSHIP DEVELOPMENT 2(1+1)

Theory: Communication Skills: Meaning and Process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills. Reading and comprehension of general and technical articles. Public speaking. Entrepreneurship Development: Concept & Meaning. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Entrepreneurial and managerial characteristics; managing an enterprise; motivational drives; entrepreneurial ethics; Entrepreneurship development Programmes SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of Entrepreneurship. Government Policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies. Contract farming and joint ventures, public-private partnerships. Social Responsibility of Business.

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

Suggested Readings:

1) Akhouri, M.M.P., Mishra, S.P. and Sen Gupta, R.1989. Trainers Manual on Developing Entrepreneurial Motivation, NIESBUD, New Delhi.
2) Bidgoli, H.1989. Decision Support Systems: Principles and Practices, St.Paul, West Publishing Co.,USA.
3) Goyal, D.P.1994. Management Information System: Concept and Application, Deep & Deep Publisher, New Delhi.
4) Mancuso, J.1974. The Entrepreneurs Handbook (Vol.192), Artech House, Inc., USA.
5) Patel, V.G.1987. Entrepreneurship Development Programme in India and Its Relevance to Developing Countries, Entrepreneurship Development Institute of India, Ahmedabad.
6) Rao, T.V.1974. Development of an Entrepreneur, Indian Institute of Management, Ahmedabad.

M.Sc. Courses

EXT 511 DEVELOPMENT PERSPECTIVES OF EXTENSION EDUCATION 2+1

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

Poverty Alleviation Programmes – SGSY, SGRY, PMGSY, DPAP, DDP, CAPART – Employment Generation Programmes – NREGP, Women Development Programmes – ICDS, MSY, RMK, Problems in Rural Development.

UNIT IV

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

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, Exposure to bottom up planning, Report preparation and presentations.

Suggested Readings

Chandrakandan KM, Senthil Kumar & Swatilaxmi. PS**.** 2005. *Extension Education*

What? And What Not ? RBSA Publ.
Gallagher K. 1999. *Farmers Field School (FFS) – A Group Extension Process based on Non-Formal Education Methods*. Global EPM Facility, FAO.
Ganesan R, Iqbal IM & Anandaraja N. 2003. *Reaching the Unreached: Basics of Extension Education*. Associated Publishing Co.
Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension*. Concept Publ.
Khan PM. 2002. *Textbook of Extension Education*. Himalaya Publ.
Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.
Van Den Ban AW & Hawkins HS. 1998. *Agricultural Extension* .2nd Ed. CBS.
Viswanathan M. 1994. *Women in Agriculture and Rural Development*. Printwell Publ.
Dubey V.K.& Bishnoi Indra 2008, Extension Education and Communication, New sage international publishers.
Supe S.V. 2009 A textbook of Extension Education, Agrotech publishing company Udaipur

EXT 512 DIFFUSION AND ADOPTION OF INNOVATIONS 2+1

Objective

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

Theory

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. Innovation system perspective.

Practical

Case studies in individual and community adoption process, content analysis of adoption studies, Identification of adopter categories on a selected technology, study of attributes of current farm technologies, Identification of opinion leaders, Sources of information at different stages of adoption on a selected technology, study of factors increasing or retarding the rate of adoption, presentation of reports on adoption and diffusion of innovations.

Suggested Readings

Dasgupta. 1989. *Diffusion Agricultural Innovations in Village India*. Wiley Eastern.

Jalihal KA & Veerabhadraiah V. 2007. *Fundamentals of Extension Education and Management in Extension.* Concept Publ. Co.

Ray GL. 2005. *Extension Communication and Management*. Kalyani Publ.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Rogers EM. 2003. Diffusion of Innovations. 5th Ed. The Free Press, New York.

C.B.Gupta 2001, Management-Theory and Pratice, Sultan Chand& Sons, Educational publishers, New Delhi.

EXT 513 RESEARCH METHODS IN BEHAVIOURAL SCIENCES 2+1

Objective

This course is designed with a view to provide knowledge and skills in methods of behavioural sciences research and student will learn the Statistical Package for Social Sciences (SPSS) for choosing appropriate statistics for data analysis.

Theory

UNIT I

Research – Meaning, importance, characteristics. Behavioural sciences research – Meaning, concept and problems in behavioural sciences research. Types and methods of Research – Fundamental, Applied and Action research, Exploratory, Descriptive, Diagnostic, Evaluation, Experimental, Analytical, Historical, Survey and Case Study. Review of literature – Need, Search Procedure, Sources of literature. Research problem – Selection and Formulation of research problem and guiding principles in the choice of research problem, Factors and criteria in selection of research problem, statement of research problem.

UNIT II

Objectives – Meaning, types and criteria for judging the objectives. Concept and Construct – Meaning, role of concepts in research and Conceptual frame work development in research. Variable – Meaning, types and their role in research. Definition – Meaning, types and their role in research. Hypothesis – Meaning, importance and functions of hypothesis in research, Types of hypothesis. Measurement – Meaning, postulates and 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 – Sampling – Types of sampling and sampling procedures.

UNIT III

Research Designs – Meaning, purpose and criteria for research design, Types, advantages and limitations of research design. Data Collection devices - Interview – Meaning, purpose, types, techniques of interviewing and advantages and limitations. Enquiry forms and Schedules – Meaning, types of questions used, steps in construction and advantages and limitations in its use. Questionnaires – Meaning, difference between schedule and questionnaire, types of questions to be used, pre – testing of the questionnaires or schedules and advantages and limitations. Check lists – Meaning, steps in construction, advantages and limitations in its use. Rating scales – Meaning, types, limits in construction, advantages and limitations in its use. Observation – Meaning, types, tips in observation, advantages and limitations in its use. Case studies – Meaning, types, steps in conducting, advantages and limitations in its use. Social survey – Meaning, objectives, types and steps in conducting, advantages and limitations.

UNIT IV

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

Practical

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

Suggested Readings

Chandrakandan K, Venkatapirabu J, Sekar V & Anand Kumar V. 2000. *Tests and Measurements in Social Research*. APH Publ.

Kerlinger FN. 1973. *Foundations of Behavioural Research*. Holt Rhinehart.

Kothari CR.1984. *Research Methodology, Methods and Techniques*. Chaitanya Publ. House.

Krishnaswami OR & Ranganatham M. 2005. *Methodology of Research in Social Sciences*. Himalaya Publ. House.

Mulay S & Sabaratnam VE.1983. *Research Methods in Extension Education*. Manasavan.

Ranjit Kumar. 1999. *Research Methodology - A Step by Step Guide for Beginners*. Sage Publ.

Ray GL & Sagar Mondal. 1999. *Research methods in Social Sciences and Extension Education*. Naya Prokash.

Wilkinson TS & Bhandarkar PC.1993. *Methodology and Techniques of Social Research*. Himalaya Publ.Home.

P.C.Tripathi 2007 research Methodology in Social Sciences Sultan Chand & Sons, Educational publishers, New Delhi A.KSingh 2002. Tests, Measurements and

Research method in behavioural Sciences. Bharti Bhawan, publishers & distributors, Patna.

EXT 521 DEVELOPMENT COMMUNICATION AND INFORMATION MANAGEMENT 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.

Practical

Collection of news items through personal interview; Writing for farm magazines, newspapers and other extension publications including folder, circular letter, feature articles, farm bulletins, new story; Writing scripts for Radio and TV; Communicating through pictures; Designing cover page of magazine and folders; Visit to different printing presses to observe their functioning.

Suggested Readings

Dahama OP & Bhatnagar OP. 2005. *Education and Communication for Development.* Oxford & IBH.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agrotech Publ. Academy.

Jana BL & Mitra KP. 2005. *Farm Journalism*. Agrotech Publ. Academy.

Ray GL. 2006. *Extension Communication and Management*. Kalyani Publ.

Rayudu CS.2002. *Communication*. Himalaya Publ. House.

Reddy AA. 1987. *Extension Education*. Sree Lakshmi Press, Bapatla.

Sandhu AS. 2004. *Textbook on Agricultural Communication Process and Methods*. Oxford & IBH.

Basavaprabhu Jirli, Dipak De, G.C.KEndadamath 2005. Information and Communication technology, Ganga Kaveri publishing House VaranasiVir Bala Aggrwal & V.S.Gupta 2001. Handbook of Jounalism concept publishing company, New Delhi.

Shaik N.Meera 2008, ICTs in Agricultural Extension, Ganga Kaveri publishing house, Varanasi.

C.S. Rayudu 1998, Communication ,Himalaya publishing house Delhi.

Kevel J. Kumar, 2008, Mass Communication in India, Jaics publishinghouse, Delhi.

Shirley A. White etal 1994,Participatory Communication, Sage Publications, New Delhi.

EXT 522 HUMAN RESOURCE DEVELOPMENT (HRD) 2+1

Objective

To orient the students about key concepts importance, scope & conceptual frame work, growth & development of Human Resource Development, Subsystems of Human Resource Development for extension organization and process of HRD.

Theory

UNIT I

Human Resource Development – Definition, Meaning, Importance, Scope and Need for HRD; Conceptual frame work, inter disciplinary approach, function systems and case studies in HRD; HRD Interventions – Different Experiences; Selection, Development & Growth- Selection, Recruitment, Induction Staff Training and Development, Career planning; Social and Organizational Culture: Indian environment perspective on cultural process and social structure, society in transition; Organizational and Managerial values and ethics, organizational commitment ; 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 Prospective.

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.

Suggested Readings

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

EXT 523 PARTICIPATORY METHODS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER 2+1

Objective

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

students will be learning the preparation of action plans, participatory monitoring and evaluation.

Theory

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.

Suggested Readings

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

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

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

Somesh Kumar. 2002. *Methods for Community Participation*. Vistaar Publ.

Mukherjee N. 1993 participating rural Appraisal Methodology and application Concept publishing company, New Delhi.

EXT 524 GENDER SENSITIZATION FOR DEVELOPMENT 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 SHG approach; 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, Women access to extension services.

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.

Suggested Readings

Grover I & Grover D. 2002. *Empowerment of Women*. Agrotech Publ. Academy.
Porter F, Smyth I & Sweetman C.1999. *Gender Works: Oxfarm Experience in Policy and Practice*. Oxfarm Publ.
Raj MK. 1998. *Gender Population and Development*. Oxford Univ. Press.
Sahoo RK & Tripathy SN. 2006. *SHG and Women Empowerment*. Anmol Publ.
Sinha K. 2000. *Empowerment of Women in South Asia*. Association of Management Development Institution in South Asia, Hyderabad.
Thakur Joshi S. 1999. *Women and Development*. Mittal Publ.
Vishwanathan M. 1994. *Women in Agriculture & RD*. Rupa Books.

EXT 531 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT IN EXTENSION 2+1

Objective

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

Theory

UNIT I

Entrepreneurship – Concept, characteristics, Approaches, Theories, Need for enterprises development. Agri – entrepreneurship – Concept, characteristics, Nature and importance for sustainable Livelihoods. Traits of entrepreneurs – Risk taking, Leadership, Decision making, Planning, Organising, Coordinating and Marketing, Types of Entrepreneurs. Stages of establishing enterprise – Identification of sound enterprise, steps to be considered in setting up an enterprise, feasibility report, product selection, risk and market analysis, legal requirements. Project Management and Appraisal – Market, Technical, Financial, Social Appraisal of Projects.

UNIT II

Micro enterprises – Profitable Agri enterprises in India – Agro Processing, KVIC

industries. Micro financing – meaning, Sources of Finance, Banks, Small scale industries development organizations. Marketing for enterprises – Concept, planning for marketing, target marketing, Competition, market survey and strategies, Product sales and promotion. Gender issues in entrepreneurship development – Understanding gender and subordination of women, Gender as a development tool, Policy approaches for women entrepreneurship development. Success and Failure stories for enterprises – Issues relating to success and failure of enterprises – Personal, Production, Finance, Social, Marketing.

UNIT III

Management – Meaning, concept, nature and importance, Approaches to management, Levels of management, Qualities and skills of a manager. Extension Management – Meaning, Concept, Importance, Principles of management, Classification of Functions of Management. Planning – Concept, Nature, Importance, Types, Making planning effective. Change Management – factors, process and procedures. Organizing – Meaning of Organization, Concept, Principles, Organizational Structure, Span of Management, Departmentalization, Authority and responsibility, Delegation and decentralization, line and staff relations.

UNIT IV

Coordination – Concept, Need, Types, Techniques of Coordination. Interpersonal relations in the organization. Staffing – Need and importance, Manpower planning, Recruitment, Selection, Placement and Orientation, Training and Development – Performance appraisal – Meaning, Concept, Methods. Direction – Concept, Principles, Requirements of effective direction, Giving orders, Techniques of direction. Leadership – Concept, Characteristics, Functions, Approaches to leadership, Leadership styles.

Organizational Communication – Concept, Process, Types, Net Works, Barriers to Communication. Managing work motivation – Concept, Motivation and Performance, Approaches to motivation. Supervision – Meaning, Responsibilities, Qualities and functions of supervision, Essentials of effective supervision. Managerial Control – Nature, Process, Types, Techniques of Control, Budgeting, Observation, PERT and CPM, MIS.

Practical

Field visit to Successful enterprises-Study of Characteristics of Successful entrepreneurs Development of Project Proposal -Case Studies of Success / Failure enterprises-Exercise on Market Survey-Field visit to Financial institutions-

Simulated exercise to understand management process-Field visit to extension organizations to understand the functions of management -Group exercise on development of short term and long term plan-Simulated exercise on techniques of decision making-Designing organizational structure -Group activity on leadership development skills.

Suggested Readings

Gupta CB. 2001. *Management Theory and Practice*. Sultan Chand & Sons.
Indu Grover. 2008. *Handbook on Empowerment and Entrepreneurship*. Agrotech Public Academy.
Khanka SS. 1999. *Entrepreneurial Development*. S. Chand & Co.
Singh D. 1995. *Effective Managerial Leadership*. Deep & Deep Publ.
Tripathi PC & Reddy PN. 1991. *Principles of Management*. Tata McGraw Hill.
Vasanta Desai. 1997. *Small Scale Industries and Entrepreneurship*. Himalaya Publ. House.
De, Dipak, 2008. Entrepreneurship- Theory and practice in Agriculture. Ganga Kaveri publishing house, Varanasi(India).
Gupta, B.L. and Kumar Anil.2009. Entrepreneurship Development. Mahamaya publishing house, Darya Ganj, New Delhi.
Viramgami, H.S. 2007 Fundamentals of Entrepreneurship (Entrepreneur and Entrepreneurship) A.P.H. publishing corporation, Darya Ganj, New Delhi.
Poonia, R.K. 2008 Entrepreneurship and the Industries Mahaveer and Sons, New Deldhi-110002.
Stoner J.A.F. Freeman, R.E. and Gilbert D.R. 2003. Management. prantice hall of India Pvt. Ltd. New Delhi.

EXT 532 MARKET LED EXTENSION MANAGEMENT 2+1

Objective

The student will learn the significance of post harvest management& value addition in present market environment and the challenges and future strategy for market led extension management. Also identifies the information sources and develop strategy for market intelligence and the marketing infrastructure, multilevel marketing and linkages for market led extension. In addition the students would be learning the public private partnerships for market led extension management, the features of contract farming, WTO its implications on agriculture and Understanding the role of IT for market intelligence.

Theory

UNIT I

Agricultural extension at cross roads; Pluralism; 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 & farmers associations 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 to study the processes and procedures related to market-led extension. Visit to successful market led models.

Suggested Readings

Kaleel FMH & Krisnamurthy J. 2007. *Market Led Extension Dimensions and Tools*. Agro Tech Publ. Academy.

Rajmanohar TP & Kumaravel KS. 2006. *Contract Farming in India*. ICFAI Univ. Press, Hyderabad.

Subbalakshmi V. 2005. *Globalization - Indian Experience*. ICFAI Univ. Press, Hyderabad.

Suresh K. 2005. *Rural Markets - Emerging Opportunities*. ICFAI Univ. Press, Hyderabad

EXT 533 VISUAL COMMUNICATION 2+1

Objective

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

Theory

UNIT I

Role of visuals & graphics in Communication. Characteristics of visuals & graphics. Functions of visuals and graphics. Theories of visual perception. Classification and selection of visuals.

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

Preparation of low cost projected and Non-Projected visuals. Designing and layout of charts, posters, flash cards etc. Power point presentations. Generating computer aided presentation graphics. Scanning and evaluation of visuals.

Suggested Readings

Bhatia A. 2005. *Visual Communication*. Rajat Publications, New Delhi.

Edgar Dale 1970. *Audio Visual methods in Teaching*. Holt, Rinehart & Winston.

James WB, Richard BL, Fried F Harcleroad. 1952. *A.V. Instructional Material &*

Methods. Mc.Graw Hill.
Reddy YN. 1998. *Audio Visual Aids in Teaching, Training and Extension*. Haritha Publ. House, Hyderabad.
Mohanty, B.B., 1965, A Handbook of Audio- Visual Aids. Khitab Mahal, Allabad.
Hars, K.B. and Packer, H.Q., 1960 preparation and use of Audio-Visual Aids, Prentice hall.
INC Englewood Cliffs.

EXT 534 E- EXTENSION 2+1

Objective

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

Theory

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 field of extension- Expert systems on selected crops and enterprises; Self learning CDs on package of practices, diseases and pest management, Agricultural web sites and portals related crop production and marketing etc.

UNIT III

Community Radio, Web, Tele, and Video conferencing. Computer Aided Extension. Knowledge management, Information kiosks, Multimedia. Online, Offline Extension. Tools-Mobile technologies, e-learning concepts.

UNIT IV

ICT Extension approaches-pre-requisites, information and science needs of farming community. Need integration. Human resource information. Intermediaries. Basic e-extension training issues. ICT enabled extension pluralism. Emerging issues in ICT.

Practical

Agril.content analysis of ICT Projects. Handling of ICT tools. Designing extension content. Online extension service. Project work on ICT enabled extension. Creation of extension blogs. Visit to ICT extension projects.

Suggested Readings

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

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

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

Jirli, B; De Dipak and Kendadamath, G.C. 2005. Information and Communication Technology (ICT) and Sustainable Development .Ganga Kaveri publishing house, Varanasi.

Roy, S.2005 Globalization, ICT and developing nations-challenge in the information sage publications, New Delhi.

EXT 535 PERSPECTIVES OF DISTANCE EDUCATION 2+1

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, 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.

Suggested Readings

Holmberg B. 1995. *Theory and Practice of Distance Education*. Routiedge Publ..
Lakshmi Reddy MV. 2001. *Towards Better Practices in Distance Education*. Kanishka Publ.
More MG. 2003. *Hand Book of Distance Education*.Lawrence Erlbaum Associates Publ.
Panda.S. 2003. *Planning & Management in Distance Education*. Kogan Page Publ.
Pathak CK. 2003. *Distance Education: Prospects and Constraints*. Rajat Publ.
Sharma DC. 2005. *Management of Distance Education*. Anmol Publ.
Sharma M. 2006. *Distance Education: Concepts and Principles*. Kanishka Publ.

Ph.D. Courses

EXT 611 ADVANCES IN TRAINING TECHNOLOGY 2+1

Objective

By the end of the Course student will be able to
• Plan and design a training programme
• Plan & Develop effective training sessions
• Manage difficult situations while organizing training programmes
• Use different advanced participatory training methods

Theory

UNIT I

Paradigm shift in training - learning scenario, Training Approaches – Experiential learning - laboratory - organization development (system) approaches; Training Design, Designing an effective training programme, Harmonizing training needs, Course Objective, content and methods.

UNIT II

Designing an effective training session - the semantics involved, Designing experiential training sessions, simulation exercises, and openness in training transaction - managing dilemmas, ambivalence and conflicts and confusion (for both trainers and trainees).

UNIT III

Recent Training Techniques for understanding and facilitation team building, group dynamics, motivation and empowerment, laboratory methods: micro-lab process work, and sensitivity training, Psychological instruments as training tools: TAT, Inventories, Cases, etc.

UNIT IV

Participatory Training Techniques - Lecture, Brainstorming, Group discussion and Training Games. Role Play, Psycho-drama, Coaching, Counseling, etc., Trainer's roles and dilemmas, Factors Effecting Training Effectiveness and Training Evaluation.

Practical

Techniques of participatory training need assessment. Formulation of Course Objective, design of training programmes. Simulation exercises. Participatory training methods - Role Play & Brainstorming, Group discussion and Counseling and Conducting experiential learning sessions. Training evaluation - Techniques of Knowledge, Skill & Attitude evaluation. Visit to training institutions and study of training technologies followed.

Suggested Readings

Agochiya D. 2002. *Every Trainer's Handbook*. Sage Publ.

Alan B & Calardy 2004. *Five Case Studies in Management Training*. Jaico Publ.

Kumar A. 2000. *Management Training Process.* Anmol Publ.

Leslie Rae. 1998. *Techniques of Training*. Jaico Publ.

Lynton RP & Pareek U. 1999. *Training for Development*. 2nd Ed. Vistar Publ.

Reid MA. 1997. *Training Interventions, Managing Employee Development*. Jaico. Publ.

Samanta RK. 1993. *Training Methods for Management and Development*. M.D. Publ.

Sethy ED. 2003. *A Practical Hand Book on Training*. Anmol Publ.

EXT 612 TRANSFER OF TECHNOLOGY IN AGRICULTURE 2+1

Objective

By the end of the Course student will be able to

• Develop thorough understanding on different systems of Technology Transfer

• Develop appropriate communication & Media Strategy suitable to the System of Technology Transfer

• Analyse the constraints in Systems of Technology Transfer Technology and Suggest suitable Strategies.

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 of 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.

Suggested Readings

Chaturvedi TN. 1982. *Transfer of Technology among Developing Countries; Need for Strengthening Cooperation*. Gitanjali Publ. House.

Dunn DD. 1978. *Appropriate Technology With a Human Face*. Macmillan Press.

Kapoor SK, Roy PB & Roy AK. 1980. *Role of Information Centres in Technology Transfer*. IASLIC, Kolakata.

Lekhi RK. 1984. *Technological Revolution in Agriculture*. Classical Publ. Co.

Singh SN. 1991. *Transfer of Technology to Small Farmers; An Analysis of Constraints and Experience*. Concept Publ. Co.

Wallender HW. 1980. *Technology Transfer of Management in the Developing Countries*. Ballinger Publ. Co., Cambridge.

EXT 613 ADVANCES IN AGRICULTURAL EXTENSION 2+1

Objective

By the End of the course student will be able to

• Critically analyze different Agricultural Extension approaches

• Understand Agricultural Knowledge Information System (AKISs) ITK

• Understand Advances in Extension - Cyber extension, ICT enabled extension services; Market Led Extension, Public Private Partnership, Mainstreaming gender in extension organizational Innovations.

• Visualize implications of WTO - AOA and develop extension strategies.

• Understand extension reforms and Farmer Field Schools Decentralized Decision Making, bottom up planning, ATMA, FSBE & CIGs etc., ATIC, IVLP & Kisan Call Centres

Theory

UNIT I

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

UNIT II

Cyber Extension - Concept of cyber extension, national and international cases of extension projects using ICT and their impact on agricultural extension, alternative methods of financing agricultural extension - Scope, limitations and experience and cases. Research - Extension -Farmer - Market linkage: Importance, Scope, Implications etc., Market - Led Extension, Farmer - Led Extension, Concept of Farm Field School, Farm School, Public - Private Partnership: Meaning, Models, Identification of various areas for partnership. Stakeholder's analysis in Extension. Main streaming gender in Extension - Issues and Prospects.

UNIT III

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

UNIT IV

Extension and contemporary issues: Extension and issues related to rural poverty. Privatization of Extension. Intellectual Property Rights (IPRs). Extension Reforms in India - Decentralized decision making, Bottom up planning, Farming System

and Situation based Extension Delivery System, Extension delivery through Commodity Interest Groups. Organization innovations in Extension - ATIC, IVLP, Kisan Call Centres.

Practical

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

Suggested Readings

Bagchi J. 2007. *Agriculture and WTO Opportunity for India*. Sanskruti.
Chambers R, Pacy A & Thrupp LA. 1989. *Farmers First*. Intermediate Technology Publ.
Crouch BR & Chamala S. 1981. *Extension Education and Rural Development*. Macmillan.
John KC, Sharma DK, Rajan CS & Singh C. 1997. *Farmers Participation in Agricultural Research and Extension Systems*. MANAGE, Concept Publ. Co.
Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.
Narasaiah ML. 2005. *Agricultural Development and World Trade Organization*. Discovery Publ.
Talwar S. 2007. *WTO Intellectual Property Rights*. Serials Publ.
Van den Ban BW & Hawkins BS. 1998. *Agricultural Extension*. S.K. Jain Publ.
Venkaiah S. 2001. *New Dimensions of Extension Education*. Anmol Publ.

EXT 614 ORGANIZATIONAL DEVELOPMENT 2+1

Objective

By the end of the course student will be able to

• Understand & Study the Organization in terms of types, Characteristics, Needs, Motives, Organization behaviour, Organization Communication, Organization development and Individual behaviour in organization.

• To anlayse the factors effecting organizational effectiveness and distinguish between functional and non functional organization.

Theory

UNIT I

Introduction to organizations: Concept and Characteristics of organizations, Organizational Behvaiour - Context and concept - levels of organizations – formal and informal organizations, Theories of organizations: Nature of organizational theory - classical theories - features of Bureaucracy - administrative theory and Scientific management - Neo-classical theories - the human relations movement - modern theory.

UNIT II

Systems approach to study organization needs and motives - Attitude, values and ethical behaviour - alienation and work - work motivation - communication and interpersonal behaviour - organization communication - leadership behaviour - decision making, problem solving techniques - organizational climate – change proneness and resistance to change, Organizational change, Organizational structure - Process in organizing - Dimension of Motivation Climate.

UNIT III

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

UNIT IV

Individual behaviour in organization. Fundamentals of Human relations and Organizational behaviour, Groups and teams - Organisational culture and performance. Dynamics of Organization behaviour - leadership conflict situations and inter group behavior- Organisational Development - Factors effecting organization effectiveness. Creativity, leadership, motivation and organization development.

Practical

Analysis of organization in terms of process - attitudes and values, motivation, leadership. Simulation exercises on problem-solving - Study of organizational climate in different organizations. Study of organizational structure of development departments, Study of departmentalization, span of control delegation of authority, decisions making patterns, Study of individual and group behaviour at work in an organization. Conflicts and their management in an organization.

Comparative study of functional and non-functional organsiations and drawing factors for organizational effectiveness.

Suggested Readings

Ancona, Kochaw, Scully, Van Maanen, Westney 1999. *Organizational Behaviour and Processes*. South Western College Publ., New York.
Banerjee M. 1984. *Organizational Behaviour*. Allied Publ.
Deka GC. 1999. *Organizational Behaviour - A Conceptual Applicational Approach*. Kanishka Publ.
Dwivedi RS. 2006. *Human Relations and Organization Behaviour- A Global Perspective.* 5th Ed. Macmillan.
Kumar A. 2000. *Organizational Behaviour Theory and Practice*. Anmol Publ.
Luthans F. 1998. *Organizational Behavior*. Tata McGraw Hill.
Luthans F. 2001. *Organizational Behaviour*. McGraw Hill.
Newstrom JW & Davis K. 1997. *Human Behaviour at Work*. Tata McGraw Hill.
Robbins SP. 2007. *Organizational Behaviour*. Prentice Hall.
Shaun T & Jackson T. 2003. *The Essence of Organizational Behaviour*. Practice Hall of India.
Stephen RR. 1999. *Organizational Behaviour*. 5th Ed. Practice Hall of India.

EXT 621 ADVANCED DESIGNS AND TECHNIQUES IN SOCIAL SCIENCE RESEARCH 2+1

Objective

By the End of the course student will be able to

• Develop & Standardize Attitude scale using different techniques of attitude scale construction.

• Develop skills of using Projected & Semi Projected Techniques, Computer Package analysis and PRA Tools in Extension Research.

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 different technique.

UNIT II

Projective and Semi projective techniques, Critical incident techniques, Computer packages for analysis - usage in Extension Research,. Knowledge test measurement. Participatory tools and techniques in behaviour Research – Data collection and Evaluation. Impact analysis, e-data collection and information analysis.

Practical

Practice in constructing a scale and use of scale in various situations. Reliability and validity of the scales developed, Application of Semi Projective and Projective techniques. Content analysis, case studies. Practicing participatory tools and techniques. Hands on experience on Computer Preparation and Data Collection instruments, review of previous studies.

Suggested Readings

Burns RB. 2000. *Introduction to Research Methods*. Sage Publ.

Chandrakandan K & Karthikeyan C. 2004. *Behavioral Research Methodology*. Classical Publ.

Daivadeenam P. 2002. *Research Methodology in Extension Education*. Agro-Tech Publ. Academy.

Kerlinger N Fred. 2002. *Foundations of Behavioural Research*. Surjeet Publ.

Kothari CR. 2000. *Research Methodology- Methods & Techniques*. 2nd Ed. Wishwa
Prakasham.

Ray GL & Mondal S. 1999. *Research Methods in Social Science and Extension Education*. Naya Prokash.

Roger L & Domino WSK. 1980. *Research Methods*. Prentice Hall.

Sadhu AM & Singh A. 2003 *Research Methodology in Social Science*. Himalaya Publ. House.

Sarantakos S. 1998. *Social Research.* 2nd Ed. Macmillan.

Sinha SC & Dhiman AK. 2002. *Research Methodology*. ESS Publ.

Verma RK & Verma G. 2002. *Research Methodology*. Commonwealth Publ.

Walizer MH & Panl L. 2002. *Research Methods & Analysis; Searching for Relationships.* Wiemil Harper & Row.

A.K.Singh 2002, Tests measurements and Research methods in behavioral Sciences, Bharti Bhawan publishers and distributors, Patna.

Allez L. Adward Techniques of attitude scale construction Tripathi P.C. 2007 A textbook of Research Methodology in social sciences, Sultan Chand & Sons Educational Publishers, New Delhi.

EXT 622 ADVANCED MANAGEMENT TECHNIQUES 2+1

Objective

By the end of the course student will be able to

• Develop understanding on concept of MIS, its scope in Agriculture Extension Organization.

• Understand, Develop and Evaluate the MBO System

• To cope up with stress, Resolve conflicts and develop effective inter personal communication skills using Transactional analysis.

• To plan & use, DSS, AI, ES, PERT, CPM

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 system.

UNIT II

Management by Course Objective (MBO): Elements of the MBO system. The Process of MBO. Making MBO effective. Evaluation of the MBO system - strengths and weaknesses. Transactional Analysis (TA): Ego states, transactions, inter relationships, strokes, stamps.

UNIT III

Managing Organizational Stress: Sources of stress in organization, effect of stress. Coping mechanisms and managing stress, Stress management, Team Building Process: Types of teams. Steps in teamwork, Facilitators and barriers to effective relationships, nature of prejudice, tips in reducing interpersonal conflicts, intergroup conflict, resolving techniques. Conflict management, tips in reducing interpersonal conflicts.

UNIT IV

Decision Support Systems (DSSs): Basic information about Artificial Intelligence (AI) Expert System (ESs), their future applications in extension system. Forecasting techniques - time series analysis and Delphi, decision making and talent management, PERT, CPM Techniques and time management.

Practical

Management Information system in research & development organizations. Study of Management by Course Objective in an organization. Transactional Analysis,

exercises on Team building process, coping skills with organizational stress, exercises on Decision Support Systems (DSSs). Practicals exercise on forecasting techniques, Visit to Management organizations.

Suggested Readings

Chaudhary AK. 1999. *Encyclopedia of Management Information System*. Vols. I, II. Anmol Publ.

Hari Gopal K. 1995. *Conflict Management - Managing Interpersonal Conflict*. Oxford & IBH.

James O'Brien 1999. *Management Information System*. Tata McGraw-Hill.

Koontz H & Welhrich H. 2004. *Essentials of Management*. 5th Ed. Tata. McGraw-Hill.

Lauden & Lauden 2003. *Management Information System*. Pearson Edu.

Maheswari BL. 1980. *Organizational Decision Styles & Orgul Effectiveness*. Vikas Publ.

McGrath SJEH. 2007. *Basic Management Skills for All*. 7th Ed. Prentice Hall of India.

623 MEDIA MANAGEMENT **2+1** **EXT**

Objective

• To familiarize the students with the working of print, electronic, New Media & Traditional folk media.

• To develop working skills needed for Print, Radio and T.V. Journalism to reach farming community.

• To develop in students an understanding on Mass Communication Process and Media Management its impact on the society.

• To develop writing skills for different media.

Theory

UNIT I

Media Management – Introduction, Definition, Principles and Significance of Management. Media Ownership patterns in India – Proprietorship, Partnership, private Ltd, Public companies, Trusts, Co-operatives, Religious Institutions (Societies) & Franchisees (Chains).

UNIT II

Mass Communication – Meaning, Concept, Definition and Theories of Mass Communication. The Mass Media – History, functions, uses and Theories of Media. Journalism – Meaning, definition, Scope, functions and different types of Journalism. Farm Journalism – meaning and Developments in Farm Journalism in India. Different problems with Farm Journalism. Print Media – History, the role of the press, news, Types of News, electronics of News and Sources of News, the making of newspaper & magazines, press codes and ethics, Media Laws. News story – Principles of writing, structure a news story, procedure in writing the news story and the elements of style. Success stories & feature articles – writing for success & feature articles, Types of Feature articles.

UNIT III

Electronic Media-Role and Importance of Radio -History, Radio Role in TOT, Different Programmes of Farm Broadcast, developing content for farm broadcast, Role of FM Radio in Agriculture, Ethics of Broad casting, Broadcasting Policy and code. Community Radio – Concept, meaning, role in TOT, Cases of Community radio. Television – History - Role in TOT, Techniques of Script writing for TV, Farm Telecast programmes, cable and satellite TV and their impact, Ethics of Telecasting, policy and code.

Video Production Technology – Potential and its utilization, Types of Video Production, Procedure or Technique of video production. Cassette Technology – Role in TOT, Techniques of production of cassettes for the farming community. Traditional Media – Role of Folk Media in TOT and integration with electronic media.

UNIT IV

Advances in communication Technology – Management of Agricultural Information System (MAIS). Use of computers in Agriculture – Application of IT in Agriculture. Use of Modern Communication Medium- Electronic Video, Teletext, tele conference, Computer assisted instruction, Video conferencing, - Features, Advantages, Limitations and risk factors involved in New Media. Designing and developing of communication and media strategy for developmental programmes

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. 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.

Suggested Readings

Bhaskaran C, Prakash R & Kishore Kumar N. 2008. *Farm Journalism in Media Management*. Agro-Tech Publ. Academy.
Chattergee PC. 1991. *Broadcasting in India*. Sage Publ.
Chiranjeev A. 1999. *Electronic Media Management*. Authors Press.
D'Souza YK.1998. *Principles and Ethics of Journalism and Mass Communication*. Commonwealth Publ.
Defleur ML & Dennis EE. 2001. *Understanding Mass Communications*. Goyalsaab Publ.
Jain SC. 2006. *International Marketing Management*. CBS Publ.
Keval J Kumar. 2004. *Mass Communication in India.* Jaico Publ.
Malhan PN. 2004. *Communication Media: Yesterday, Today and Tommorow*. Directorate of Publication Division, New Delhi.
Mehta DS. 1992. *Mass Communication and Journalism in India*. Allied Publ.
Panigrahy D. 1993. *Media Management in India*. P. K. Biswasroy (Ed.). Kanishka Publ.
Shrivastava KM. 1995. *News Writing for Radio and TV*. Sterling Publ.
Sinha KK. 2001. *Business Communications*. Galgotia Publ.

EXT 624 ADVANCED INSTRUCTIONAL TECHNOLOGY 2+1

Objective

By the end of the course student will be able to

• Understand Agricultural Education Scenario in the country and Curriculum development process
• Plan & Prepare and present course outline, Lesson Plan & Skill plan
• Develop appropriate Teaching & Learning Styles
• Use innovative instructional aids & methods

Theory

UNIT I

Concepts in Instructional Technology, Scope of Instructional Technology. History of agricultural education in India. Guidelines for curriculum development in Agricultural Universities. Curriculum design development.

UNIT II

Course outline, Lesson plans for theory and practicals. Teaching and learning styles. Theories of learning. Cognitive levels. Instructional Course Objective. Motivation of students.

UNIT III

Instructional Methods. Experiential learning cycle. Innovative Instructional Aids. Computer Assisted Instruction. Programmed instruction technique. Team Teaching. E-Learning, Art of Effective Communication. Distance education. Student evaluation - Question Bank. Appraisal of Teacher Performance. Review of research in Instructional Technology.

Practical

Formulation of instructional Course Objective. Development and presentation of course outlines. Preparation & presentation of lesson plans for theory & practical with CAI design. Preparation of innovative low cost instructional aids. Development of model question bank. Preparation of schedule for teacher evaluation. Visit to Distance Education centre. Study of research reviews and Presentation of reports.

Suggested Readings

Agarwal JC. 2007. *Essentials of Educational Technology Innovations in Teaching – Learning*. 2nd Ed. Vikas Publ. House.

Agarwal R. 2000. *Educational Technology and Conceptual understanding*. Anmol Publ.

Dayal BK. 2005. *Educational Planning and Development*. Dominant Publ.

Grover I, Kaushik S, Yadav L & Varma SK. 2002. *Communication and Instructional Technology*. Agro Tech Publ. Academy.

Jacobsen D, Eggen P & Kauchak D. 1985. Methods for Teaching - A Skills Appraoch. 2nd Ed. Charles E. Merrill Publ.

Joyee B & Well M. 1980. *Models of Teaching*. 2nd Ed. Prentice Hall.

Khan PM. 2002. *Text Book of Extension Education*. Himanshu Publ.

Rush N. 1987. *Technology Based Learning - Selected Readings*. London Publ. Co., New York.

Tara Chand 1999. *Educational Technology*. Anmol Publ.

EXT 625 THEORY CONSTRUCTIONS IN SOCIAL SCIENCES 3+0

Objective

By the end of the course student will be able to develop skills of theory building and scientific application of theoretical concept in Social Sciences by applying appropriate statistical tests.

Theory

UNIT I

Importance of theory constructions in social science. Theory: Meaning, elements, Ideal Criteria, Functions, Types. Definitions: Meaning, types and Rules. Generalizations: Meaning, Classification. Relationship: Meaning Types.

UNIT II

Terminologies used in theory constructions: Axiom, Postulate, Proposition, Theorem, Fact, Concept, Construct, Probability and Measurement Basic Derived. Steps in theory building - Axiomatic Techniques, Historical approaches. Scientific application. Theoretical concept in Social Sciences. Test of Theory: Applying appropriate statistical tests.

Suggested Readings

Blalock HM. *Theory Construction: Form verbal to Mathematical Formulations*. Prentice Hall.

Dubin R. *Theory Building*. The Free Press, New York.

Gibbs JP. *Sociological Theory Construction*. The Dryden Press, Illionis.

Hage J. *Techniques and Problems of Theory Constructions in Sociology*. John Wiley & Sons

Stinchombe AL. *Construction of Sociological Theories*. Harcourt, Brace & World.

Wionton CA. *Theory and Measurement in Sociology*. John Wiley & Sons.

DEPARTMENT OF AGRONOMY

PROGRAMMES

1. M.Sc.
2. Ph.D.

COURSE REQUIREMENTS
M.Sc.

Field of specialization	Crop production, Nutrient management, Weed management, Water management, Crop physiology, Organic farming
Core courses	Agron 511, Agron 512, Agron 513, Agron 531
Optional courses	Agron 521, Agron 522, Agron 523, Agron 524, Agron 525, Agron 526, Agron 532, Agron 533, Agron 534, Agron 535, Agron 536
Minor & supporting courses	Stat 511, Stat 521, Pphys 521 or as per decision of advisory committee in view of research problem
Non credit compulsory courses	PGS 502, PGS 503
Deficiency courses	Nil or as deemed suitable by advisory committee

Ph.D.

Field of specialization	Crop production, Nutrient management, Weed management, Water management, Crop physiology, organic farming, Cropping systems
Core courses	Agron 611, Agron 612
Optional courses	Agron 613, Agron 614, Agron 621, Agron 622, Agron 623, Agron 624
Minor & supporting courses	Stat 612, Stat 622, Pphys 522 or as per decision of advisory committee in view of research problem
Non credit compulsory courses	PGS 502, PGS 503 (Exempted if done in M.Sc.)
Deficiency courses	Nil or as deemed suitable by advisory committee

DESCRIPTION OF COURSES

Undergraduate courses

AGRON - 111 PRINCIPLES OF AGRONOMY AND AGRICULTURAL METEOROLOGY 3(2+1)

Theory:

Meaning and Scope of Agronomy; National and International Agricultural Research Institutes and Agricultural Universities of India; Agroclimatic zones of India and Rajasthan.

Classification of crops; Tillage; Sowings; Planting geometry; Crop stand establishment and its effects on growth and yield; Cropping systems; Harvesting, threshing and winnowing

Agrometeorology, weather and climate, micro-climate, weather elements; Earths' atmosphere: composition and structure; solar radiation: nature, properties, depletion, solar constant and energy balance; Atmospheric temperature: factors affecting, horizontal and vertical distribution variations, global warming; Air pressure: Variations; Wind: Factors affecting cyclones and anticyclones and general circulation; Atmospheric humidity: vapor pressure and saturation, process of condensation, formation of dew, fog, mist, snow, rain and hail; Formation and classification of clouds; Introduction to monsoon ; Basics of weather forecasting.

Practical:

Study of tillage implements; Practice of ploughing and puddling; Study of seeding equipments and different methods of sowing; Study of manures, green manure crops; Seed & fertilizers calculations; Study of intercultivation equipments and practice; Study of fertilizer application methods and practice; Participation in on going field operations at Instructional Farm; Site selection for Agromet observatory and installation of instruments; Measurement of Atmospheric and Soil temperature; Measurement of rainfall, evaporation, relative humidity, atmospheric pressure, solar radiation and wind direction and velocity; Study of weather forecasting and synoptic charts.

Suggested Readings:

1. Lal, D.S.2005. Climatology, Sharda Pustak Bhawan, Allahbad
2. Sahu, D.D.2003. Agrometeorology and Remote Sensing: Principles and Practices, Agrobios (India), Jodhpur
3. Varshneya, M.C. and Balakrishana, Pillai, P.2003. Textbook of Agricultural Meteorology, ICAR, New Delhi
4. Balasubramaniyan, P. and Palaniappan, S.P.2001. Principles and Practices of Agronomy, Agrobios (India), Jodhpur

5. Reddy, S.R. 2004. Principles of Agronomy, Kalyani Publishers, Ludhiana
6. Reddy, S.R.2000. Principles of Crop Production, Kalyani Publishers, Ludhiana
7. ICAR. 2006. Handbook of Agriculture, Indian Council of Agricultural Research, New Delhi
8. iksjoky] ch- ,y-] flag] iq"isUnz ,oe~ 'kekZ] Mh- Mh- 2000- lL; foKku ds ewy rRo] ds- ih- izdk'ku] mn;iqj

AGRON -121 WEED MANAGEMENT 2 (1+1)

Theory:

Weeds: Introduction, harmful and beneficial effects, classification, propagation, dissemination and persistence; 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; Integrated weed management; Herbicides: advantages and limitations of herbicide use in India; Classes of herbicides, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Weed management in major cereals, pulses, oilseeds, fibre and forage crops; Problematic weeds and their control *viz.Parthenium hysterophorus, Cynodon dactylon, Orobanche* and *Striga* .

Practical:

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of weed herbarium; Determination of weed density and intensity; Physical weed control; 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 application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops and weeds; Biology of weeds; Economics of weed control practices; Tours and visits of problem areas.

Suggested Readings:

1. Gupta, O.P.2005. Weed Management: Principles and Practices (2nd Ed.), Agribios (India), Jodhpur.

2. Gupta, O.P.2002. Modern Weed Management, Agribios (India), Jodhpur.
3. Rao, V.S. 2000. Principals of Weed Science (2nd Ed.), Oxford and IBH Publishing Co., New Delhi.
4. Saraswat, V.N., Bhan, V.M. and Yaduraju, N.T.2003. Weed Management, ICAR, New Delhi.

AGRON - 122 WATER MANAGEMENT 3(2+1)

Theory:

Importance of water in plants; Irrigation: definition and objectives; Water resources and irrigation development in India and Rajasthan; Forms of soil water and soil moisture constants; Methods of soil moisture determination, evapotranspiration and crop water requirement; Scheduling of irrigation; Methods of irrigation: surface, sprinkler and drip irrigation; Irrigation efficiency and water use efficiency; Irrigation water quality and its management; Conjunctive use of water; Water management of different crops *viz.* rice, wheat, maize, sugarcane, and important pulses and oilseed crops; Agricultural drainage.

Practical:

Determination of bulk density by field method; Determination of soil moisture content by gravimetric method, tensiometer, electrical resistance block and neutron moisture meter; Determination of field capacity by field method; Determination of permanent wilting point; Measurement of irrigation water through flumes and weirs; Calculation of irrigation water requirement (Problems); Demonstration of irrigation methods *viz.* surface, sprinkler and drip methods; Calculation of irrigation efficiency; Acquaintance and upkeep of sprinkler and drip irrigation systems; Visit to farmers field and cost estimation of drip irrigation system; Determination of EC, pH, and $Ca^{++} + Mg^{++}$ of irrigation water

Suggested Readings:

1. Lenka, D.1999. Irrigation and Drainage. Kalyani Publishers, L.D.H., New Delhi.
2. Michael, A.M.1987. Irrigation: Theory and Practice, Vikas Publishing House, New Delhi.
3. Mishra, R.D. and Ahmed, M. 1987. Manual on Irrigation Agronomy, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Parihar, S.S., and Sandhu B.S.1987. Irrigation of Field Crops – Principles and Practices, ICAR, New Delhi.

5. Reddy, S.R. 2000. Principles of Crop Production, Kalyani Pub. , New Delhi.

ENVS - 121 ENVIRONMENTAL STUDIES 3(2+1)

Unit 1: The Multidisciplinary nature of environmental studies: Environmental studies: Definition, nature and Scope; Need for public awareness, measures to create awareness for healthy environment.

Unit 2: Natural Resources: Renewable and non-renewable sources: National resources: Definition, types and conservation; Forest resources: Use and over exploitation, deforestation, case study, Timber extraction, mining, dams and their effects on forests and tribal people; Water resources: Uses and over utilization of surface and ground water, floods, drought, conflicts over water, dams benefits and problems; Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies; Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies; Energy resources: Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources. Case studies; Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification; Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

Unit 3. Ecosystem: Concept of ecosystem; Structure and function of an ecosystem, Producers, consumers and decomposers; Energy flow in the ecosystem. Ecological succession; Food chains, food webs and ecological pyramids; Introduction, types, characteristics features, structure and function of Forest ecosystem; Grassland ecosystem,; Desert ecosystem and Aquatic ecosystems**.**

Unit 4: Biodiversity and its conservation: Biodiversity – definition and types; Biogeographical classification of India; Value of biodiversity: consumptive use, productive use, social ethical, and aesthetic and option value; Biodiversity at global, national and local levels; India as a mega-diversity nation, Hot-spots of biodiversity; Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; Endangered and endemic species of India; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit5: Environmental pollution: Definition, causes, effects and control measures of: Air pollution, Water pollution, Soil pollution and Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards; Solid waste management: Causes, effects and control measures of urban and industrial wastes; Role of an

individual in prevention of pollution. Pollution case studies; Disaster management: floods, earthquake, cyclone and landslides.

Unit 6: Social issues and the environment: From unsustainable to sustainable development. Urban problems related to energy; Water conservation, rainwater harvesting, and watershed management; Resettlement and rehabilitation of people; its problems and concerns, Case studies; Environmental ethics: Issues and possible solutions; Climatic change, global warming, acid rain ozone layer depletion, nuclear accidents and holocaust, Case studies; Wasteland reclamation. Consumerism and waste products; Environment Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act. Forest Conservation Act; Issues involved in enforcement of environmental legislation; Public awareness.

Unit 7: Human Population and the Environment: Population growth, variation among nations; Population explosion – Family Welfare Programme; Environment and human health, Human Rights; Value education, HIV/ Aids; Women and Child Welfare; Role of Information Technology in Environment and human health, Case studies.

Unit 8:Fieldwork: Visit to a local area to document environmental assets-river/forest/grassland/hill/mountain; Visit to a local polluted site – Urban/Rural/Industrial/Agricultural; Study of common plants, insects, birds; Study of simple ecosystems-pond, river, hill slopes, etc.

Suggested Readings:

1. Bamaniya, B.R., Verma, L. N. and Verma A. 2005. Fundamentals of Environmental Studies, Yash Publishing House, Bikaner.
2. Rathore, N. S. and Singh, Pratap 2004. Environmental Studies, Himanshu Publishing House, New Delhi.
3. Choudhary, B.L. and Pandey, J. 2004. Environmental Studies, Apex Publishing House, Udaipur.
4. pkS/kjh] ch- ,y- ,oa ikaMs] ftrsUnz- 2004- i;kZoj.k v/;;u] ,isDl ifCyf'kax gkml] mn;iqjA
5. dkSf'kd] vuqHkk ,oa dkSf'kd] lh- ih- 2005- i;kZoj.k v/;;u] U;w ,t bUVjus'kuy ¼izk½ fyfeVsM] ubZ fnYyhA
6. tkxsfV;k] ch- ,y- vkSj iqjksfgr] iadt 2005- i;kZoj.k v/;;u] ,xzksVsd ifCyf'kax ,dsMeh] mn;iqjA

AGRON - 211 FIELD CROPS-I (*KHARIF*) 3(2+1)

Theory:

Study of following crops with reference to their importance; Origin; Geographic distribution and production in Rajasthan and India; Soil and climatic requirements; varieties; Cultural practices *viz* .Seed and sowing; Intercultural operations; Fertilizer, water and weed management; Plant protection measures; Harvesting and yield.

Pearl millet, Sorghum, Maize, Rice, Groundnut, Soybean, Pigeonpea and Cotton.

Study of package of practices of the following crops:

Minor millets, Urdbean, Mothbean, Cowpea, Mungbean, Clusterbean, Sunflower, Sunnhemp, Castor, Sesame and Napier; Bio energy crops *viz*. Jatropha and Jojoba.

Practical:

Identification of seeds and crops of *kharif* season & others inputs; Seed bed preparation and sowing of *kharif crops* ; Calculations on seed rate; Effect of seed size on germination and seedling vigour of soybean/ groundnut; Preparation of seed material for sowing; Fertilizer application in various crops and study of Fertilizer experiments; Plant protection measures; Irrigation operation in various crops; Weed control in *kharif* crop and study of weed control experiments; Judging physiological maturity of various crops; Study of yield attributing characters and yield calculations in *kharif* crops; Crop harvesting and processing; Working out cost of production of two crops; Calculation of harvest index; Study of crop varieties and important agronomic experiments; Study of forage experiments.

Suggested Readings:

1. Singh, Chhidda, Singh, Prem and Singh, Rajbir.2003. Modern Techniques of Raising Field Crops, Oxford & IBH Publishing Co., New Delhi.
2. Singh, S.S.1998. Crop Management Under Irrigated and Rainfed Conditions. Kalyani Publishers, New Delhi.
3. Singh, S.S.1993. Principles and Practices of Agronomy, Kalyani Publishers, New Delhi. Kalyani Publishers, New Delhi.
4. Rathore, P.S. 2000. Techniques and Management of Field Crop Production, Agrobios (India), Jodhpur.
5. Prasad, Rajendra 2002. Text Book of Field Crop Production, ICAR, New Delhi.
6. ICAR. Handbook of Agriculture 2006. Indian Council of Agricultural Research, New Delhi
7. 'kDrkor] eksgu flag ,oa O;kl] vHk; dqekj 2000. oSKkfud Qly izcU/ku] ;'k ifCyf'kax gkml] chdkusj

AGRON - 221 FIELD CROPS-II (*RABI)* 3(2+1)

Theory:

Study of following crops with reference to their importance; Origin; Geographic distribution and production in Rajasthan and India; Soil and climatic requirements; varieties; Cultural practices *viz* .Seed and sowing; Intercultural operations; Fertilizer, water and weed management; Plant protection measures; Harvesting and yield:

Wheat, Barely, Rapeseed and mustard, Chickpea, Sugarcane, Potato and. Berseem, Lucerne

Study of package of practices of the following crops:

Linseed, Safflower, Sugarbeet, Lentil, Frenchbean, and Oats.

An introduction to the importance and cultivation of Medicinal & aromatic plants *viz.* Isabgol, Opium poppy, *Mentha*, Lemon grass, Citronella and Palma rosa.

Practical:

Identification of seeds and crops of *rab*i season; Seed bed preparation and sowing of *rab*i crops; Calculations on seed rate; Preparation of seed material for sowing; Fertilizer application in crops and study of fertilizer experiments; Irrigation and plant protection measures; Weed flora and there control measure and study of weed control experiment; Judging physiological maturity of various crops; morphological characteristics of wheat, sugarcane, chickpea and mustard; Judging sugarcane maturity and quality test; Crop harvesting and processing; Calculation of harvest index, Working out cost of production of two crops; Crop distribution in the state and region, Important Agronomic experiments of *rabi* crops; Visit to research stations related to *rabi* crops.

Suggested Readings:

1. Singh, Chhidda, Singh, Prem and Singh, Rajbir 2003. Modern Techniques of Raising Field Crops. Oxford & IBH Publishing Co., New Delhi.
2. Singh, S.S.1998. Crop Management Under irrigated and Rainfed Conditions Kalyani Publishers, New Delhi
3. Singh, S.S., 1993. Principles and Practices of Agronomy, Kalyani Publishers, New Delhi.

4. Rathore, P.S. 2000.Techniques and Management of Field Crop Production, Agrobios (India), Jodhpur.
5. Prasad, Rajendra 2002. Text Book of Field Crop Production, ICAR, New Delhi.
6. Prajapati, N.D., Purohit, S.S., Sharma, A.K. and Kumar, T. 2003. A Handbook of Medicinal Plants: A Complete Source Book, Agrobios (India), Jodhpur
7. ICAR, 2006 & 1980. Handbook of Agriculture, Indian Council of Agricultural Research, New Delhi
8. Kumar, N., Kader Md. Abdul, JBM, Rangaswami, P. and Irulappam, I. 1997. Introductin to Spices, Plantation Crops, Medicinal and Aromatic Plants. Oxford & IBH Publishing Co. Ltd., New Delhi
9. 'kDrkor] eksgu flag ,oa O;kl] vHk; dqekj 2000- oSKkfud Qly izcU/ku] ;'k ifCyf'kax gkml] chdkusj
10. pUnzk] ohjsUnz ,oa ikaMs;] eqdqy pUnz- 2004 tM+h cwfV;ksa dh [ksrh] Hkkjrh; d`f"k vuqla/kku ifj"kn~] ubZ fnYyh

AGRON 311 - PRACTICAL CROP PRODUCTION-II (*KARIF* CROPS) 1(0+1)

Practical:

Crop planning; Raising field crops in multiple cropping systems: field preparation, seed treatment, sowing, Nutrient, water and weed management; Management of insect, pest and diseases of crops; Harvesting, threshing, drying, winnowing, storage and marketing of produce; Preparation of balance sheet including cost of cultivation, net return per student as well as per team of a group of student.

Suggested Readings:

1. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1992. Manures and Fertilizers, Agri-Horticultural Pub. House, Nagpur.
2. Balasubramaniyan, P. and Palaniappan, S. P.2001. Principles and Practices of Agronomy, Agrobios (India), Jodhpur.
3. Reddy, S. R., 2004. Principles of Agronomy, Kalyani Publishers, Ludhiana.
4. Singh, S.S., 1993. Principles and Practices of Agronomy, Kalyani Publishers, Ludhiana.

AGRON - 312 FARMING SYSTEMS AND SUSTAINABLE AGRICULTURE 2(1+1)

Theory:

Farming systems: definition, principles, scope and components; IFS models for wetland, irrigated, and dryland situations; Components of Farming systems; Interactions among components of different enterprises; Resource management under constrained situations; Low cost and non monetary inputs particularly for wasteland and problematic soils.

Sustainable agriculture: Introduction, definition, goal and current concepts; Indices of sustainability; Emerging issues fro present day technologies; Factors affecting ecological balance; Ameliorative measures and management practices for sustainable agriculture *viz.* soil, water sources, rain water and integrated pest management; Land degradation and conservation of natural resources; LEISA, LEIA & HEIA; Irrigation problems, waste lands and their development.

Practical:

Preparation of cropping scheme for irrigated situations; Preparation of cropping scheme for dryland situations; Study of existing farming systems in nearby villages; Preparation of integrated farming system model for wetlands; Preparation of integrated farming system model for drylands; 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 an organic farm to study various components and utilization; Study of degraded lands.

Suggested Readings:

1. Panda, S.C.2004. Cropping Systems and Farming Systems, Agrobios (India), Jodhpur
2. Sharma, Arun K. 2002. A Handbook of Organic Farming, Agrobios (India) Ltd., Jodhpur
3. Balasubramaniyan, P. and Palaniappan, S.P. 2004. Principles and Practices of Agronomy, Agrobios (India), Jodhpur.
4. Shukla, Rajeev K. 2004. Sustainable Agriculture, Surbhee Publications, Jaipur
5. Palaniappan, S.P.1985. Cropping Systems in the Tropics: Principles and Management, Wiley Easter Ltd. and TNAU, Coimbatore.
6. Reddy S. R. 2004. Principles of Agronomy, Kalyani Publishers, Ludhiana.
7. Palaniappan, S.P. and Sivaraman, K. 1996. Cropping system in Tropics, New International Pvt. New Delhi.
8. xkSre] vkj.lh. ,oa flag] iatkc-1997- fVdkÅ [ksrh] Hkkjrh; d`f"k vuqlU/kku ifj"kn] ubZ fnYyh

AGRON - 313 ORGANIC FARMING 3 (2+1)

Theory:

Introduction, concept, relevance in present context and future prospects; Organic production requirements; Principles, objectives and components of organic farming; Biological intensive nutrient management-organic manures, composting, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports.

Practical:

Aerobic and anaerobic methods of compost making, , Techniques of treating legume seeds with *Rhizobium* culture, Use of *Azotobacter, Azospirillum* and PSB culture in field crops; Raising of crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post harvest management; Visit to organic farm.

Suggested Readings:

1. Dhama, A.K. 1999. Organic Farming, Agro Botanica, Bikaner
2. Sharma, Arun K.2002. A Handbook of Organic Farming, Agrobios (India), Jodhpur
3. Palaniappan, S.P. and Anandurai, K.1999. Organic Farming – Theory and Practice, Scientific Pub. Jodhpur
4. Thapa, U and Tripathy, P. 2006. Organic Farming in India: Problems and Prospects, Agrotech, Publising Academy, Udaipur.
5. 'kekZ] v:.k ds- 2005. tSfod [ksrh & fl)kUr] rduhd o mi;ksfxrk] ,xzksck;ksl ¼bf.M;k½] tks/kiqj

AGRON - 321 PRACTICAL CROP PRODUCTION-II (*RABI* CROPS) 1(0+1)

Practical:
Crop planning; Raising field crops in multiple cropping systems: field preparation, seed treatment, sowing, Nutrient, water and weed management; Management of insect, pest and diseases of crops; Harvesting, threshing, drying, winnowing, storage and marketing of produce; Preparation of balance sheet including cost of cultivation, net return per student as well as per team of a group of student.

Suggested Readings:

1. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 1992. Manures and Fertilizers, Agri-Horticultural Pub. House, Nagpur.
2. Balasubramaniyan, P. and Palaniappan, S. P.2004. Principles and Practices of Agronomy, Agrobios (India), Jodhpur.
3. Reddy, S. R. 2002. Principles of Agronomy, Kalyani Publishers, Ludhiana.
4. Singh S.S. 1993. Principles and Practices of Agronomy, Kalyani Publishers, Ludhiana.

AGRON 322 - INTRODUCTORY AGRICULTURE (ANCIENT HERITAGE, AGRICULTURAL SCENARIO AND GENDER EQUITY IN AGRICULTURE) 1(1+0)

Theory:
Art, Science and business of crop production, Basic elements of crop production; Factors affecting crop production; History of Agricultural Development; Ancient India Agriculture in Civilization Era, Chronological Agricultural Technology development in India. Indian Agriculture, balance sheet, liabilities; Assets and Contrasting trends (DATA), Agricultural growth, Diversity in physiography, Soil groups, marine, livestock and water; Liabilities: Soil factors, weather factors, Economic ecology, dry and irrigation agriculture, value addition, requirements in new technology; Women in Agriculture: multifaceted roles and tasks, work stress factors, Nutritional and rural life standards, role in house hold 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.

Suggested Readings:

1. ICAR, 2006. Handbook of Agriculture, Indian Council of Agricultural Research, New Delhi

2. Morachan, Y.B. 1989. Crop Production and Management, Oxford & IBH Publishing Co., New Delhi
3. Verma, S. 1992. Women in Agriculture (A Socio-economic Analysis), Concept Publication Company, New Delhi
4. Randhawa, M.S. 1980. A History of Agriculture in India Vol. I, ICAR, New Delhi
5. Randhawa, M.S. 1982. A History of Agriculture in India Vol. II, ICAR, New Delhi
6. Randhawa, M.S. 1983. A History of Agriculture in India Vol. III, ICAR, New Delhi
7. Randhawa, M.S. 1986. A History of Agriculture in India Vol. IV, ICAR, New Delhi
8. Choudhary, S.L. Sharma, G.S. And Nena, Y.L. (Ed.) 2000. Ancient and Medieval History of Indian Agriculture, Proceedings of the Summer School held from 28 May-17 June, 1999. Rajasthan College of Agriculture, Udaipur

Experiential learning courses

AGRON - 421 INTEGRATED WATERSHED MANAGEMENT 4 (2+2)

Theory:

Watershed: concept, importance and use; Factors affecting watershed management; Principles of watershed management; Objectives of watershed management, delineation & toposequence of watershed area; Land capability classification; Specific problems of watershed area; Components of watershed management; Agronomical measures for soil and water conservation; Soil and water conservation for arable and non-arable lands; Horticulture and forestry for watershed area; Execution of proposed plan for development and conservation of soil, water and vegetation resources ; Crop management in watershed areas ; Evaluation of systems in terms of stability and sustainability of programme executed; Studies of soils, vegetation and socio-economic status of watershed area ; Modification of plan during execution based on ground needs ; Monitoring of the growth, productivity and resources with various systems.

Practical:

Study of on going watershed management programmes; Identification of grass and tree species suitable for soil and water conservation; Study of soil and water conservation measures as per land use capability classification (Arable lands); Study of soil and water conservation measures as per land use capability classification (Non-arable lands); Measures for in - situ moisture conservation; Visit to model watershed areas of the zone IV a and b; Dry seeding practices suitable for watershed areas and after care; Acquaintance with different soil conservation structures *viz.* terraces, bunds water ways etc., Practicing suitable agronomic measures for sustainable crop production in watershed areas ; Alternate land use systems in watershed areas ; Study of water storage structures for watershed areas ; Visit to forest areas of zone IV a and b

Suggested Readings:

1. Murthy, J. V. S. 1994. Watershed Management, Wiley Eastern Limited. New Age International Limited, New Delhi.
2. Dhruva Narayan, V.V. Singh, P.P., Bhardwaj, S.P., U. Sharma, Sikha, A.K., Vital, K.P.R. and Das, S.K. 1987. Watershed Management for Drought Mitigation, ICAR, New Delhi.
3. Singh, R.P., Sharma, S., Padmnabhan, N.V. , Das, S.K. and Mishra, P.K. 1990.A Field Manual on Watershed Management, ICAR (CRIDA), Hyderabad.
4. Singh, P.K. 2000. Watershed Management (Design & Practices), e-media Publication, Udaipur, India.
5. Yadav, N.D., Soni, M.L. and Beniwal, R.K. 2002. Techniques for Integrated Watershed Development (In Hindi)
6. Singh, Rajveer. 2003. Watershed Planning and Management. Yash Publishing House, Bikaner
7. Singh, G.D. and Poonia, T.C. 2003. Fundamentals of Watershed Management Technology. Yash Publishing House, Bikaner

AGRON - 422 MANAGEMENT OF PROBLEM SOILS 4 (1+3)

Theory:

Characteristics and distribution of saline, sodic, calcareous, acid and water logged soils; Plant response to soil reaction; Nutrient imbalance in problem soils; Extent of damage to crops; Crop tolerance to salinity, alkalinity, acidity and water logging; reclamation of problem soils; Role of soil amendments and soil drainage; Agronomic practices in relation to problem soils; Cropping systems for problem soils.

Practical:

Appraisal and diagnosis of salt affected soils and their management: Evaluation of pH, EC, RSC, SAR, GR, OC, water holding capacity, hydraulic conductivity, permeability, soluble cations and anions; Determination of N,P,K,S and micronutrients of soil samples of problem areas; Visit to problem areas : Field diagnosis of salt affected soils; Reclamation measures: hydro technical, chemical and biological.

Suggested Readings:

1. Singh, K.N., Kumar, A. and Sharma, D.K.1998. Management of Problem Soils. *In:* Yadav, R.L., Singh, P., Prasad, R. and Ahlawat, I.P.S. (Ed.) Fifty Years of Agronomic Research in India, Indian Society of Agronomy, New Delhi.

2. USDA. 1954. Diagnosis and Improvement of Saline and Alkali Soil USDA. Hand book-60. USDA, Washington, DC.
3. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. 1982. Saline and Alkali Soils of India, ICAR, New Delhi.
4. Brady, N.C. and Weil R.R. 2003. Elements of the Nature and Properties of Soils, Prentice Hall, New Jersey.
5. Maliwal, G.L. and Somani, L.L. 2010 Nature, Properties and Management of Saline and Alkali Soils, Agro-tech Publishers, Udaipur
6. Maliwal, G.L. and Somani, L.L. 2010 Soil Technology, Agro-tech Publishers, Udaipur
7. Sudharmani Devi C.R. 2005. Analytical Procedures in Soil Science and Agricultural Chemistry, Agro-tech Publishers, Udaipur
8. Mohsin, M.A., Sarkar, A.K. and Mathur, B.S.1995. Acid Soil Management, Kalyani Publishers, New Delhi.

AGRON-423 APPLIED WEED MANAGEMENT 3(1+2)

Theory:

Weed: definition, damages caused; Elements of weed prevention and control; Concept of Integrated weed management; Physical weed control methods: manual, mechanical and soil solarization; Weed control through agronomic practices; Biological weed control: Classical approach and bio-herbicides, Herbicidal control: Classes and methods of herbicide application; Sprayers: components and calibration

Weed management in field crops *viz.* paddy, wheat, maize and millets, groundnut, linseed, rapeseed and mustard, soybean, chickpea, pigeonpea, lentil, sugarcane, cotton, cumin, fenugreek, lucerne, berseem and vegetable crops; Control of parasitic weeds *viz*. *Striga, Orabanchae, Cuscuta* ,and *Loranthus*

Practical:

Identification and preservation of seasonal and perennial weeds; Practice in manual and mechanical weed control and use of improved implements; Acquaintance with herbicides- their manufacturers and potential uses; Visit to weed control trials to

record observations on density, intensity and dry matter; Herbicide application equipments and their calibration; Herbicide calculations; Herbicide spray in cropped and non-cropped area; Recording herbicide toxicity; Economics of weed control; Qualitative and quantative analysis of weedy vegetation; Bioassay for herbicide residue estimation; Control of *Parthenium hysterophorous*; Visits to observe weed problem on farmers' fields and aquatic ecosystem.

Suggested Reading:

1. Saraswat, V.N., Bhan, V.M. and Yaduraju, N.T. 2003. Weed Management, ICAR, New Delhi.
2. Gupta, O.P. 2005. Weed Management: Principles and Practices (2nd Ed.), Agribios (India), Jodhpur
3. Shanmugavelu, K.G., Aravindan, R. and Rajagopal, A. 2004. Weed Management in Horticultural Crops, Agrobios (India), Jodhpur
4. Gupta, O.P.2008. Modern Weed Management, Agribios (India), Jodhpur.
5. Das, T.K. 2008. Weed Science: Basics and Applications, Jain Brothers, New Delhi

Post graduate courses

AGRON 511 PRINCIPLES AND PRACTICES OF WEED MANAGEMENT 2+1

Objective

To familiarize the students about the weeds, herbicides and methods of weed control.

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-herbicides, myco-herbicides and

allelochemicals; Degradation of herbicides in soil and plants; herbicide resistance in weeds and crops; herbicide rotation.

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

- Identification of important weeds of different crops
- Preparation of a weed herbarium
- Weed survey in crops and cropping systems
- Crop-weed competition studies
- Preparation of spray solutions 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
- Herbicide resistance analysis in plant and soil
- Bioassay of herbicide resistance
- Calculation of herbicide requirement

Suggested Readings

1. Aldrich RJ & Kramer RJ. 1997. *Principles in Weed Management*. Panima Publ.
2. Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley Inter-Science.
3. Gupta OP. 2008. *Modern Weed Management.* Agrobios.
4. Naylor REL. 2002. *Weed Management Hand Book*. Blackwell Publishing.
5. Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH.
6. Sarswat VN, Bhan VM & Yaduraju NT. 2003. *Weed Management*. ICAR
7. Singh HP, Batish DR & Kohli RK. 2006. *Sustainable Weed Management*. Food Products Press – An imprint of The Haworth Press Inc.

8. Streibig JC & Kudsk P. 1993. *Herbicide Bioassay*. CRC Press Inc.
9. Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 512 PRINCIPLES AND PRACTICES OF WATER MANAGEMENT 2+1

Objective

To teach the principles of water management and practices to enhance the water productivity.

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 moisture constants; 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; microirrigation 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 moisture by using tensiometer, and pressure plate and membrane
apparatus
• Soil-moisture 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

Suggested Readings

1. Lenka D. 1999. *Irrigation and Drainage*. Kalyani
2. Mishra RD & Ahmed M. 1990. *Manual on Irrigation Agronomy*. Oxford & IBH Publishing Co. Pvt. Ltd.
3. Michael AM. 1978. *Irrigation: Theory and Practice*. Vikas Publ.
4. Paliwal KV. 1972. *Irrigation with Saline Water*. IARI Monograph, New Delhi.
5. Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.
6. Prihar SS & Sandhu BS. 1987. *Irrigation of Food Crops - Principles and Practices*. ICAR.
7. Reddy SR. 2000. *Principles of Crop Production*. Kalyani.

AGRON 513 PRINCIPLES AND PRACTICES OF SOIL FERTILITY AND NUTRIENT MANAGEMENT 2+1

Objective

To impart knowledge of fertilizers and manures as sources of plant nutrients and apprise about the integrated approach of plant nutrition and sustainability of soil fertility.

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 functions, nutrient deficiency symptoms; transformation and dynamics of major plant nutrients.

UNIT III

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

UNIT 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 fertilizer 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 vermicompost and residue wastes in crops.

Practical

• Determination of soil pH, ECe, organic C, total N, available N, P, K and S in soils

• Determination of total N, P, K and S in plants

• Interpretation of interaction effects and computation of economic and yield optima

Suggested Readings

1. Brady NC & Weil R.R 2002. *The Nature and Properties of Soils.* 13th Ed. Pearson Edu.
2. Fageria NK, Baligar VC & Jones CA. 1991. *Growth and Mineral Nutrition of Field Crops.* Marcel Dekker.

3. Gupta PK. 2007. *A Hand Book of Soil, Fertilizer and Manures*. Agribios
4. Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.
5. Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
6. Somani LL. 1996. *Efficient Use of Fertilizers*. Agrotech Publishing Academy.
7. Yawalkar KS, Agrawal JP & Bokde S. 2000. *Manures and Fertilizers*. Agri-Horti Publ.

AGRON 521 AGROMETEOROLOGY AND CROP WEATHER FORECASTING 2+1

Objective

To impart knowledge about agro-meteorology and crop weather forecasting to meet the challenges of aberrant weather conditions.

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 budget of plant canopies; environmental temperature: soil, air and canopy temperature.

UNIT III

Temperature profile in air, soil, crop canopies; soil and air temperature effects on plant processes; environmental moisture and evaporation: measures of atmospheric temperature and relative humidity vapor pressure and their relationships; evapo-transpiration 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

• Measurement/estimation of soil water balance

• Rainfall variability analysis

• Determination of heat-unit requirement for different crops

• Measurement of crop canopy temperature

• Measurement of soil temperatures at different depths

• Remote sensing and familiarization with agro-advisory service bulletins

• Study of synoptic charts and weather reports, working principle of automatic weather station

• Visit to solar observatory

Suggested Readings

1. Chang Jan Hu 1968. *Climate and Agriculture on Ecological Survey*. Aldine Publ.
2. Critchfield HJ.1995. *General Climatology.* Prentice Hall of India.
3. Das PK.1968. *The Monsoons*. National Book Trust Publ.
4. Lal DS.2005. *Climatology*. Sharda Pustak Bhawan.
5. Lenka D.1998. *Climate, Weather and Crops in India*. Kalyani.
6. Mavi H.S.1994. *Introduction to Agro-meteorology*. Oxford & IBH.
7. Mavi HS & Tupper GJ. 2004. *Agrometeorology: Principles and Application of Climate Studies in Agriculture.* Haworth Press.
8. Menon PA.1991. *Our Weather.* National Book Trust Publ.
9. Sahu DD. *Agrometeorology and Remote Sensing: Principles and Practices*. Agrobios.
10. Variraju R & Krishnamurty 1995. *Practical Manual on Agricultural Meteorology*. Kalyani.
11. Varshneya MC & Balakrishana Pillai P. 2003. *Textbook of Agricultural Meteorology*. ICAR.

AGRON -522 PRINCIPLES OF SOIL MANAGEMENT AND CROP PRODUCTION 3+0

Objective

To study various aspects of soil and crop management practices, water deficit and excess stress situation and management thereof.

Theory

UNIT I

Tillage: definition, objectives, types and its effect on physical properties on soil; Concept of zero tillage; Concept of minimum tillage.

UNIT II

Soil fertility management in crop production: Plant nutrients – criteria of essentiality and forms of uptake, Role and deficiency symptoms of plant nutrients;

Concept of balanced fertilization and integrated nutrient management; Nutrient management in cereal/ pulse based cropping systems; Concepts regarding

UNIT III

Precision farming and Site specific nutrient management; Organic matter : Importance, benefits, composition and decomposition; Factors affecting decomposition and detrimental effects; Crop residue management ; Classification and reclamation of saline and sodic soils; Management of saline and sodic soils.

UNIT IV

Constraints/Problems of crop production in different agro-climatic zones of Rajasthan; Seeds and their role in crop production; Concepts of optimum plant population, planting geometry and ideal plant type; Concepts regarding cropping systems-monoculture, crop rotation, multiple , Cropping, relay cropping, mixed cropping and intercropping;

UNIT V

Water stress in relation to crop growth; Soil fertility and moisture interaction; Agronomic manipulation for higher yield in dryland agriculture; Excess soil water and crop growth; Agronomic practices for poorly drained soils; Weed management in crop production.

Suggested Readings

1. Singh SS.1988. *Crop Management under Irrigated and Rainfed conditions*, Kalyani Publishers
2. Morachan YB. 1986. *Crop Production and Management*, Oxford & IBH Publishing Co

3. Singh KN, Bhattacharya HC, Mishra BN and Ahlawat IPS.1988. *Major Crop Production Constraints and Their Remedial Measures for Different Agro Climatic Zones of India*, ICAR
4. Reddy T, Yellamandu & Reddi, G.H. Sankara. 1992. *Principles of Agronomy*, Oxford & IBH Publishing Co
5. Tisdale SL, Nelson WL, Beaton JD & Halvin JL. 1995.*Soil Fertility and Fertilizers*, Prantice Hall of India Pvt. Ltd
6. Reddy SR.1999. *Principles of Agronomy*, Kalyani PublishersReddy, S.R.2000. Principles of Crop Production, Kalyani Publishers, New Delhi.
7. Halvin JL Beaton JD Tisdale SL & Nelson WL.2005.*Soil Fertility and Fertilizers: An Introduction to Nutrient Management*, Prentice Hall of India Pvt. Ltd
8. Panda SC. 2004. *Cropping and Farming Systems*, Agrobios (India)
9. Singh Gurriqbal Kotar JS & Sekhon HS. 2002. *Recent Advances in Agronomy*, Indian Society of Agronomy
10. Balasubramaniyan P & Pilanippan SP. 2004. *Principles and Practices of Agronomy*, Agrobios (India)
11. Nilsen ET & Orcutt DM. 1996. *The Physiology of Plants under Stress*: Abiotic Factors, John Wiley & Sons Inc.

AGRON 523 SOIL CONSERVATION AND WATERSHED MANAGEMENT **2+1**

Objective

To teach about different soil moisture conservation technologies for enhancing the agricultural productivity through holistic approach watershed management.

Theory

UNIT I

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

UNIT II

Soil conservation: definition, methods of 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 measurements
- 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

Suggested Readings

1. Arakeri HR & Roy D. 1984. *Principles of Soil Conservation and Water Management*. Oxford & IBH.
2. Dhruvanarayana VV. 1993. *Soil and Water Conservation Research in India*. ICAR.

3. FAO. 2004. *Soil and Water Conservation in Semi-Arid Areas*. *Soils Bull.,* Paper 57.
4. Frederick RT, Hobbs J, Arthur D & Roy L. 1999. *Soil and Water Conservation: Productivity and Environment Protection.* 3rd Ed. Prentice Hall.
5. Konkhe KH & Bertrand AR. 1969. *Soil Conservation*. McGraw Hill Book Int. Co.
6. Michael AM & Ojha TP. 1981. *Principles of Agricultural Engineering* Vol. II, Jain Brothers.
7. Murthy VVN. 1995. *Land and Water Management Engineering*. Kalyani.
8. Tripathi RP & Singh HP. 1993. *Soil Erosion and Conservation*. Wiley Eastern.
9. Yellamanda Reddy T & Sankara Reddy GH. 1992. *Principles of Agronomy*. Kalyani.

AGRON 524 DRYLAND FARMING 2+1

Objective

To teach the basic concepts and practices of dry land farming and soil moisture conservation.

Theory

UNIT I

Definition, concept and characteristics of dry land farming; dry land versus 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 land areas; types of drought, characterization of environment for water availability; crop planning for erratic and aberrant weather conditions.

UNIT III

Stress physiology and resistance to drought, adaptation of crop plants to drought, drought management strategies; preparation of appropriate crop plans for dry land areas; mid contingent plan for aberrant weather conditions.

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 (use of mulches, kinds, effectiveness and economics); antitranspirants; 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-transpirants 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 dryland farming

• Visit to dryland research stations and watershed projects

Suggested Readings

1. Das NR. 2007. *Tillage and Crop Production*. Scientific Publishers.
2. Dhopte AM. 2002. *Agrotechnology for Dryland Farming*. Scientific Publ.
3. Gupta US. (Ed.). 1995. *Production and Improvements of Crops for Drylands*. Oxford & IBH.
4. Katyal JC & Farrington J. 1995. *Research for Rainfed Farming*. CRIDA.

5. Rao SC & Ryan J. 2007. *Challenges and Strategies of Dryland Agriculture*. Scientific Publishers.
6. Singh RP. 1988. *Improved Agronomic Practices for Dryland Crops*. CRIDA.
7. Singh RP. 2005. *Sustainable Development of Dryland Agriculture in India*. Scientific Publ.
8. Singh SD. 1998. *Arid Land Irrigation and Ecological Management*. Scientific Publishers.
9. Venkateshwarlu J. 2004. *Rainfed Agriculture in India. Research and Development Scenario*. ICAR.

AGRON 525 CROPPING SYSTEMS AND SUSTAINABLE AGRICULTURE **3+0**

Objective

To acquaint the students about prevailing cropping systems in the country and practices to improve their productivity.

Theory

UNIT I

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

UNIT II

Concept of sustainability in cropping systems and farming systems, scope and objectives; 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; research need on sustainable agriculture.

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.

UNIT V

Plant ideotypes for drylands; plant growth regulators and their role in sustainability.

Suggested Readings

1. Palaniappan SP & Sivaraman K. 1996. *Cropping Systems in the Tropics; Principles and Management.* New Age.
2. Panda SC. 2003. *Cropping and Farming Systems*. Agrobios.
3. Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
4. Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy.* The Bangalore Printing & Publ. Co.
5. Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.
6. Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1997. *Soil Fertility and Fertilizers*. Prentice Hall.

AGRON 526 AGRONOMY OF MAJOR CEREALS AND PULSES 2+1

Objective

To teach the crop husbandry of cereals and pulse crops.

Theory

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

UNIT I

Rabi cereals: Wheat & barley

UNIT II

Kharif cereals: Paddy, maize, sorghum & pearl millet

UNIT III

Rabi pulses: Chick pea

UNIT IV

Kharif pulses: Pigeon pea

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 sizes 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

• Planning and layout of field experiments

• 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

• Visit of field experiments on cultural, fertilizer, weed control and water management aspects

• Visit to nearby villages for identification of constraints in crop production

Suggested Readings

1. Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.

2. Hunsigi G & Krishna KR. 1998. *Science of Field Crop Production*. Oxford & IBH.
3. Jeswani LM & Baldev B. 1997. *Advances in Pulse Production Technology*. ICAR.
4. Khare D & Bhale MS. 2000. *Seed Technology*. Scientific Publ.
5. Kumar Ranjeet & Singh NP. 2003. *Maize Production in India: Golden Grain in Transition*. IARI, New Delhi.
6. Pal M, Deka J & Rai RK. 1996. *Fundamentals of Cereal Crop Production*. Tata McGraw Hill.
7. Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.
8. Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
9. Singh, SS. 1998. *Crop Management*. Kalyani.
10. Yadav DS. 1992. *Pulse Crops*. Kalyani.

AGRON 531 MODERN CONCEPTS IN CROP PRODUCTION 3+0

Objective

To teach the basic concepts of soil management and crop production.

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 in cereals; physiology of grain yield in cereals; optimization of plant population and planting geometry in relation to different resources, concept of ideal plant type and crop modeling for desired crop yield.

UNIT IV

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

UNIT V

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

Suggested Readings

1. Balasubramaniyan P & Palaniappan SP. 2001. *Principles and Practices of Agronomy*. Agrobios.
2. Fageria NK. 1992. *Maximizing Crop Yields*. Marcel Dekker.
3. Havlin JL, Beaton JD, Tisdale SL & Nelson WL. 2006. *Soil Fertility and Fertilizers.* 7th Ed. Prentice Hall.
4. Paroda R.S. 2003. *Sustaining our Food Security*. Konark Publ.
5. Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publ.
6. Sankaran S & Mudaliar TVS. 1997. *Principles of Agronomy*. The Bangalore Printing & Publ.
7. Singh SS. 2006. *Principles and Practices of Agronomy*. Kalyani.

AGRON 532 AGRONOMY OF OILSEED, FIBRE AND SUGAR CROPS 2+1

Objective

To teach the crop husbandry of oilseed, fiber and sugar crops.

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

Rabi oilseeds – Rapeseed & mustard, linseed.

UNIT II

Kharif oilseeds - Groundnut, sesame, soybean etc.

UNIT III

Fiber crops - Cotton, sunhemp.

UNIT IV

Sugar crops –Sugarcane.

Practical

• Planning and layout of field experiments

• Cutting of sugarcane setts, its treatment and methods of sowing, tying and propping of sugarcane

• Determination of cane maturity and calculation on purity percentage, recovery percentage and

sucrose content in cane juice phenological studies at different growth stages of crop

• Intercultural operations in different crops

• Cotton seed treatment

• Working out growth indices (LER, CGR, RGR, NAR, LAD) aggressivity, relative crowding

coefficient, monetary yield advantage and ATER of prominent intercropping systems

• 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 fibre of different fibre 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 villages for identification of constraints in crop production

Suggested Readings

1. Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
2. Das PC. 1997. *Oilseed Crops of India*. Kalyani.
3. Lakshmikantam N. 1983. *Technology in Sugarcane Growing*. 2nd Ed. Oxford & IBH.
4. Prasad, Rajendra. 2002. *Text Book of Field Crop Production*. ICAR.
5. Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops.* Oxford & IBH.
6. Singh SS. 1998. *Crop Management*. Kalyani.

AGRON 533 AGRONOMY OF FODDER AND FORAGE CROPS 2+1

Objective

To teach the crop husbandry of different forage and fodder crops along with their processing.

Theory

UNIT I

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

UNIT II

Adaptation, distribution, varietal improvement, agro-techniques and quality aspects including anti-quality factors of important forage crops/grasses lime, napier grass, *Panicum, Lasiuras, Cenchrus* etc.

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

Economics of forage cultivation uses and seed production techniques.

Practical

• Practical raining of farm operations in raising fodder crops;

• 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

Suggested Readings

1. Chatterjee BN. 1989. *Forage Crop Production - Principles and Practices*. Oxford & IBH.
2. Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
3. Narayanan TR & Dabadghao PM. 1972. *Forage Crops of India*. ICAR.
4. Singh P & Srivastava AK. 1990. *Forage Production Technology*. IGFRI, Jhansi.
5. Singh C, Singh P & Singh R. 2003. *Modern Techniques of Raising Field Crops*. Oxford & IBH.
6. Tejwani KG. 1994. *Agroforestry in India*. Oxford & IBH.

7. Tyagi ID. 2002. *Modern Agriculture*: New Paradigm. Jain Brothers.

AGRON 534 AGRONOMY OF MEDICINAL, AROMATIC AND UNDER-UTILIZED CROPS **2+1**

Objective

To acquaint students about different medicinal, aromatic and underutilized field crops, their package of practices and processing.

Theory

UNIT I

Importance of medicinal and aromatic plants 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 requirements; 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 requirements; cultural practices; yield and important constituents of aromatic plants (Citronella, Palmarosa, Mentha, Basil, Lemon grass, Rose, Patchouli, Geranium etc.).

UNIT IV

Climate and soil requirements; cultural practices; yield of under-utilized crops (Rice bean, Lathyrus, Sesbania, Clusterbean, French bean, Fenugreek, Grain Amaranth, Coffee, Tea and Tobacco).

Practical

• Identification of crops based on morphological and seed characteristics

• Raising 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

Suggested Readings

1. Chadha KL & Gupta R. 1995. *Advances in Horticulture*. Vol. II. *Medicinal and Aromatic Plants*. Malhotra Publ.
2. Das NR. 2007. *Introduction to Crops of India*. Scientific Publ.
3. Handa SS. 1984. *Cultivation and Utilization of Medicinal Plants*. RRL, CSIR, Jammu.
4. Hussain A. 1984. *Essential Oil Plants and their Cultivation*. CIMAP, Lucknow.
5. Hussain A. 1993. *Medicinal Plants and their Cultivation.* CIMAP, Lucknow.
6. ICAR 2006. *Hand Book of Agriculture.* ICAR, New Delhi.
7. Kumar N, Khader Md. Abdul, Rangaswami JBM & Irulappan 1997. I*ntroduction to Spices, Plantation Crops, Medicinal and Aromatic Plants.* Oxford & IBH.
8. Prajapati ND, Purohit SS, Sharma AK & Kumar T. 2003. *A Hand Book of Medicinal Plants: A Complete Source Book*. Agrobios.
9. Sharma R. 2004. *Agro-Techniques of Medicinal Plants*. Daya Publ. House.

AGRON 535 AGROSTOLOGY AND AGRO-FORESTRY 2+1

Objective

To teach crop husbandry of different forage, fodder and agroforestry crops/trees along with their processing.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Crop production technology in agro-forestory and agrostology system; silvipastoral system: meaning and importance for wasteland development; selection of species, planting methods and problems of seed germination in agro-forestry systems; irrigation and manuring in agro-forestry systems, associative influence in relation to above ground and underground interferences; lopping and coppicing in agro-forestry systems; social acceptability and economic 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 grasses and trees in silvipastoral system

• Fertilizer application in strip and silvipastroal systems
• After-care of plantation
• Estimation of protein content in loppings 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

Suggested Readings

1. Chatterjee BN & Das PK. 1989. *Forage Crop Production. Principles and Practices.* Oxford & IBH.
2. Dabadghao PM & Shankaranarayan KA. 1973. *The Grass Cover in India*. ICAR.
3. Dwivedi AP. 1992. *Agroforestry- Principles and Practices.* Oxford & IBH.
4. Indian Society of Agronomy. 1989. *Agroforestry System in India. Research and Development,* New Delhi.
5. Narayan TR & Dabadghao PM. 1972. *Forage Crop of India*. ICAR, New Delhi.
6. Pathak PS & Roy MM. 1994. *Agroforestry System for Degraded Lands*. Oxford & IBH.
7. Sen NL, Dadheech RC, Dashora LK & Rawat TS. 2004. *Manual of Agroforestry and Social Forestry.* Agrotech Publ.
8. Shah SA.1988. *Forestry for People*. ICAR.
9. Singh Panjab, Pathak PS & Roy MM.1994. *Agroforestry System for Sustainable Use*. Oxford & IBH.
10. Singh SP. 1994. *Handbook of Agroforestry.* Agrotech Publ.
11. Solanki KR. 2000. *Multipurpose Tree Species: Research, Retrospect and Prospects*. Agrobios.
12. Tejwani KG.1994. *Agroforestry in India.* Oxford & IBH.
13. Tyagi ID. 2002. *Modern Agriculture*: New Paradigm. Jain Brothers.

AGRON 536 PRINCIPLES AND PRACTICES OF ORGANIC FARMING **2+1**

Objective

To study the principles and practices of organic farming for sustainable crop production.

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 biofertilizers.

UNIT III

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

UNIT IV

Control of weeds, diseases and insect pest management, biological agents and pheromones, biopesticides.

UNIT V

Socio-economic impacts; marketing and export potential: inspection, certification, labeling and accreditation procedures; organic farming and national economy.

Practical

• Aerobic and anaerobic methods of making compost

• Making of vermicompost

• Identification and nursery raising of important agro-forestry tress and tress for shelter belts

• Efficient use of biofertilizers, 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 labeling and accreditation procedures for farm

produce from organic farms

Suggested Readings

1. Ananthakrishnan TN. (Ed.). 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.
2. Gaur AC. 1982. *A Manual of Rural Composting*, FAO/UNDP Regional Project Document, FAO.
3. Lampin N. 1990. *Organic Farming*. Press Books, lpswitch, UK.
4. Palaniappan SP & Anandurai K. 1999. *Organic Farming – Theory and Practice.* Scientific Publ.
5. Rao BV Venkata. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*: Publ.3, Parisaraprajna Parishtana, Bangalore.
6. Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
7. Sharma A. 2002. *Hand Book of Organic Farming*. Agrobios.
8. Singh SP. (Ed.) 1994. *Technology for Production of Natural Enemies.* PDBC, Bangalore.
9. Subba Rao NS. 2002. *Soil Microbiology*. Oxford & IBH.
10. Trivedi RN.1993. *A Text Book of Environmental Sciences*, Anmol Publ.
11. Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture.* Association for Promotion of Organic Farming, Bangalore.
12. WHO. 1990. *Public Health Impact of Pesticides Used in Agriculture*. WHO.

13. Woolmer PL & Swift MJ. 1994. *The Biological Management of Tropical Soil Fertility*. TSBF & Wiley.

Ph.D. courses

AGRON 611 ADVANCES IN CROP GROWTH AND PRODUCTIVITY **2+1**

Objective

To study the physiology of vegetative and reproductive growth in relation to productivity of different crops in various environments.

Theory

UNIT I

Plant density and crop productivity; plant and environmental factors, yield, plant distribution, strategies for maximizing solar energy utilization; 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 conditions; 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: crop physiological and new 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

Suggested Readings

1. Chatterjee BN, S. Maiti & Mandal BK. 1989. *Cropping System:* Theory & Pratice. Oxford & IBH Publishing Co. Pvt. Ltd.
2. Chopra VL & Paroda RS. 1984. *Approaches for Incorporation of Drought and Salinity Resistance in Crop Plants*. Oxford and IBH.
3. Franklin P, Gardner, R.Brent Pearce & Roger L. Mitchell. 1985. *Physiology of Crop Plants*. Scientific Publishers.
4. Lincoin Taiz & Eduardo Zeiger. 2002. *Plant Physiology* 3rd Ed. Panima Publishing Corporation.

5. Evans LT. 1975. *Crop Physiology*. Cambridge Univ. Press.
6. Evans LT. 1996. *Crop Evolution, Adaptation and Yield*. Cambridge Univ. Press.
7. Gupta US. (Ed.). 1995. *Production and Improvement of Crops for Drylands*. Oxford & IBH.
8. Gupta US. 1988. *Progress in Crop Physiology*. Oxford and IBH.
9. Kramer PJ & Boyer JS. 1995. *Water Relations of Plant and Soils.* Academic Press.
10. Mukherjee S & Ghosh AK. 1996. *Plant Physiology*. Tata McGraw Hill.
11. Narwal SS, Politycka B & Goswami CL. 2007. *Plant Physiology: Research Methods.* Scientific Publishers.
12. Palaniappan, SP & Shivaraman K. 1996. *Cropping System in The Tropics*. Principles and Management. New Age International (P) Ltd. Publisher.
13. Reddy SR. 2000. *Principles of Crop Production*. Kalyani Publishers.
14. Salisbury FB & Ross CW. 1986. *Plant Physiology*. CBS Publishers & Distributors.
15. Verma SC & Singh MP. 1987. *Agronomy of New Plant Types*. Tara Book Co.
16. Hilmann M. 1990. *Synthetic Plant Growth Regulators*. Advance Agronomy. 43: 48-105.

AGRON 612 ADVANCES IN WEED MANAGEMENT 3+0

Objective

To teach about the changing weed flora, new herbicides, their resistance, toxicity, antidotes and residue management under different cropping systems.

Theory

UNIT I

Crop-weed competition in different cropping situations; changes in weed flora, various causes and affects.

UNIT II

Important herbicide families & molecules; herbicide absorption, translocation, metabolism and mode of action; selectivity of herbicides and factors affecting them.

UNIT III

Climatic 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

Development of transgenic herbicide resistant crops; herbicide development, registration procedures.

UNIT VI

Relationship of herbicides with tillage, fertilizer and irrigation; bioherbicides, allelochemical herbicide bioassays.

Suggested Readings

1. Aldrich RJ & Kramer R.J. 1997. *Principles in Weed Management*. Panama Publ.
2. Ashton FM & Crafts AS. 1981. *Mode of Action of Herbicides*. 2nd Ed. Wiley-Inter Science.
3. Gupta OP. 2008. *Modern Weed Management*. Agrobios.
4. Naylor REL. 2002. *Weed Management Hand Book*. Blackwell Publishing.
5. Prados RDe, Jarrin J & Torres L. 1997. *Weed and Crop Resistance to Herbicides*. Kluwer Academic Publisher.
6. Rao VS. 2007. *Principles of Weed Science*. Oxford & IBH.

7. Ross MA & Carola Lembi A. 1999. *Applied Weed Science.* 2nd Ed. Prentice Hall.
8. Subramanian SAM & Kumar R.J. 1997. *All About Weed Control*. Kalyani.
9. Zimdahl RL. 1999. *Fundamentals of Weed Science*. 2nd Ed. Academic Press.

AGRON 613 IRRIGATION MANAGEMENT 2+1

Objective

To teach students about optimization of irrigation in different crops under variable agroclimatic conditions.

Theory

UNIT I

Water resources of India, irrigation projects; 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, scheduling of irrigation in field crops..

UNIT III

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

UNIT IV

Methods and Application of irrigation water, conveyance and distribution system, irrigation efficiency; agronomic considerations in the 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

Suggested Readings

1. FAO. 1984. *Irrigation Practice and Water Management.* Oxford & IBH.
2. Michael AM. 1978. *Irrigation: Theory and Practice*.Vikas Publ.
3. Mishra RD & Ahmad M. 1987. *Manual on Irrigation and Agronomy*. Oxford & IBH.
4. Panda SC. 2003. *Principles and Practices of Water Management*. Agrobios.
5. Reddy SR. 2000. *Principles of Crop Production*. Kalyani.
6. Sankara Reddy GH & Yellamananda Reddy 1995. Efficient Use of Irrigation Water. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.
7. Singh SS. 2006. Principles and Practices of Agronomy. In: Gupta US. (Ed.). *Production and Improvement of Crops for Drylands*. Oxford & IBH.

AGRON 614 CROP ECOLOGY 3+0

Objective

To acquaint the students about the agricultural systems, agro-ecological regions, and adaptation of crops to different agro-climatic conditions.

Theory

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.

Suggested Readings

1. Ambasht RS. 1986. *A Text Book of Plant Ecology*. 9th Ed. Students' Friends & Co.

2. Chadha KL & Swaminathan MS. 2006. *Environment and Agriculture*. Malhotra Publ. House.
3. Dhaliwal GS & Kler DS. 1995. *Principles of Agricultural Ecology*. Himalaya Publishing House.
4. Dwivedi P, Dwivedi SK & Kalita MC. 2007. *Biodiversity and Environmental Biotechnology.* Scientific Publ.
5. Hemantarajan A. 2007. *Environmental Physiology*. Scientific Publ.
6. Kumar HD. 1992. *Modern Concepts of Ecology*. 7th Ed. Vikas.Publ.
7. Lenka D. 1998. *Climate, Weather and Crops in India*. Kalyani.
8. Misra KC. 1989. *Manual of Plant Ecology*. 3rd Ed. Oxford & IBH.
9. Pandey SN & Sinha BK. 1995. *Plant Physiology*. Vikas Publ.
10. Sharma PD. 1998. *Ecology and Environment*. Rastogi Publ.
11. Singh J & Dhillon SS. 1984. *Agricultural Geography.* Tata McGraw Hill.
12. Taiz L & Zeiger E. 1992. *Plant Physiology*. Benjamin/Cummings Publ.

AGRON 621 CURRENT TRENDS IN AGRONOMY 3+0

Objective

To acquaint the students about recent advances in agricultural production.

Theory

UNIT I

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

UNIT II

Globalization of agriculture and WTO, precision agriculture, contract arming, organic farming, marketing and export potential of organic poducts, certification, labeling 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.

UNIT IV

GIS, GPS and remote sensing for crop management, global warming, GM crops, seed production technology; seed certification, seed multiplication, hybrid seed production etc.

UNIT V

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

Suggested Readings

1. Agarwal RL. 1995. *Seed Technology*. Oxford & IBH.
2. Dahiya BS & Rai KN. 1997. *Seed Technology*. Kalyani.
3. Govardhan V. 2000. *Remote Sensing and Water Management in Command Areas: Agroecological Prospectives*. IBDC.
4. ICAR. 2006. *Hand Book of Agriculture*. ICAR.
5. Narasaiah ML. 2004. *World Trade Organization and Agriculture*. Sonali Publ.
6. Palaniappan SP & Annadurai K. 2006. *Organic Farming - Theory and Practice*. Scientific Publ.
7. Sen S & Ghosh N. 1999. *Seed Science and Technology*. Kalyani.
8. Sheaffer CC & Moncada KM. 2009. *Introduction to Agronomy: Food, Crops and Environments*. Delmar Cengag Learning.
9. Tarafdar JC, Tripathi KP & Mahesh Kumar 2007. *Organic Agriculture* Scientific Publ.

AGRON 622 STRESS CROP PRODUCTION 2+1

Objective

To study various types of stresses in crop production and strategies to overcome them.

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 temperature tress through, soil and crop manipulations.

UNIT III

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

UNIT IV

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

UNIT V

Excess water or flooding stress: meaning of excess water stress, its kinds and effects on crop plants, 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 in 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 injury under field conditions

Suggested Readings

1. Baker FWG.1989. *Drought Resistance in Cereals*. Oxon, UK.
2. Gupta U.S. (Ed.). 1988. *Physiological Aspects of Dryland Farming.* Oxford & IBH.
3. Kramer PJ.1983. *Water Relations of Plants*. Academic Press.
4. Levitt J. 1980. *Response of Plants to Environmental Stresses*. Vols. I, II. Academic Press.
5. Mavi HS.1978. *Introduction to Agro-meteorology*. Oxford & IBH.
6. Michael AM & Ojha TP.1981. *Principles of Agricultural Engineering*. Vol II. Jain Bros.
7. Nilsen ET & Orcut DM. 1996. *Physiology of Plants under Stress – Abiotic Factors*. John Wiley & Sons.
8. Salisbery FB & Ross CW. 1988. *Plant Physiology*. CBS Publishers and Distributors.
9. Singh K. 2000. *Plant Productivity under Environmental Stress*. Agribios.
10. Somani LL & Totawat KL. 1992. *Management of Salt-affected Soils and Waters.* Agrotech Publ.
11. Somani LL. 1996. *Efficient Use of Fertilizers*. Agrotech Publishing Academy.

12. Virmani SM, Katyal JC, Eswaran H & Abrol IP.1994. *Stressed Ecosystem and Sustainable Agriculture*. Oxford & IBH.

AGRON 623 INTEGRATED FARMING SYSTEMS FOR SUSTAINABLE AGRICULTURE **3+0**

Objective

To apprise about different enterprises suitable for different agroclimatic conditions for sustainable agriculture.

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; 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.

Suggested Readings

1. Ananthakrishnan TN. (Ed.) 1992. *Emerging Trends in Biological Control of Phytophagous Insects*. Oxford & IBH.
2. Balasubramanian P & Palaniappan SP 2006. *Principles and Practices of Agronomy*. Agrobios.
3. Joshi M & Parbhakarasetty TK. 2005. *Sustainability through Organic Farming*. Kalyani.
4. Lampin N. 1990. *Organic Farming*. Farming Press Books.
5. Palaniappan SP & Anandurai K. 1999. *Organic Farming - Theory and Practice*. Scientific Publ.
6. Panda SC. 2004. *Cropping systems and Farming Systems*. Agribios.
7. Reddy MV. (Ed.). 1995. *Soil Organisms and Litter Decomposition in the Tropics*. Oxford & IBH.
8. Sharma AK. 2001. *A Hand Book of Organic Farming*. Agrobios.
9. Singh KN & Singh RP. 1990. *Agronomic Research towards Sustainable Agriculture*. Indian Society of Agronomy, IARI.
10. Singh SP. (Ed) 1994. *Technology for Production of Natural Enemies*. PDBC, Bangalore.
11. Trivedi RN. 1993. *A Text Book of Environmental Sciences*. Anmol Publ.
12. Veeresh GK, Shivashankar K & Suiglachar MA. 1997. *Organic Farming and Sustainable Agriculture*. Association for Promotion of Organic Farming, Bangalore.
13. Venkata Rao BV. 1995. *Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective*. Publ. 3. Parisaraprajna Parishtana, Bangalore.

AGRON 624 CROP PRODUCTION AND SYSTEM MODELING 2+1

Objective

To familiarize the students about systems approach and to simulate yields and growth of several crops under varied soil and weather conditions with different management practices and their optimization.

Theory

UNIT I

Systems classification; flow charts, modeling 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 modeling methods for crop-weather interaction, climate change and variability components.

UNIT IV

Potential production: leaf and canopy CO2 assimilation, respiration, dry matter accumulation, crop phenology 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

Suggested Readings

1. Gordan G. 1992. *System Simulation*. 2nd Ed. Prentice Hall.
2. Kropff MJ & Vann Laar HH. (Ed.). 1993. *Modelling Crop Weed Interactions*. ISBN.

3. Mathews RB, Kropff MJ, Bachelet D & Vaan Laar HH. (Eds.). 1993. *Modelling the Impact of Climate Change on Rice Production in Asia.* CABI.
4. Penning de Vries FWT & Van Laar HH. (Eds.). 1982. *Simulation of Plant Growth and Crop Production*. Wageningen Centre for Agricultural Publications and Documentation, Netherlands.
5. Ritchie JT & Hanks J. 1991. *Modelling Plant and Soil Systems*. American Society of Agronomy, Madison.
6. Zeigler BP. 1976. *Theory of Modeling and Simulation*. John Wiley & Sons.

DEPARTMENT OF ENTOMOLOGY
RAJASTHAN COLLEGE OF AGRICULTURE
(Maharana Pratap University of Agriculture & Technology)
Udaipur 313 001 (Rajasthan)

PROGRAMMES

1. M. Sc.
2. Ph.D.

COURSE REQUIREMENTS

M. Sc.

Field of specialization	Insect Pests Management, Morphology and Anatomy, Physiology and Nutrition, Taxonomy, Toxicology, Ecology, Biological Control and Storage
Core courses	ENT. 511, ENT. 512, ENT. 513, ENT. 531
Optional courses	ENT. 521, ENT. 522, ENT. 523, ENT. 524, ENT. 525, ENT. 532, ENT.533, ENT. 534, ENT.535, ENT. 591, ENT. 599 (Research)
Minor & supporting courses	
Non credit compulsory courses	ENT. 541
Deficiency courses	Nil or as deemed suitable by advisory committee

Ph. D.

Field of specialization	Insect Pests Management, Morphology and Anatomy, Physiology and Nutrition, Taxonomy, Toxicology, Ecology, Biological Control and Storage
Core courses	ENT. 611, ENT. 612, ENT. 613
Optional courses	ENT. 614, ENT. 622, ENT. 623, ENT. 624,

	ENT. 691, ENT. 692, ENT. 699 (Research)
Minor & supporting courses	
Non credit compulsory courses	ENT. 621, ENT. 641
Deficiency courses	Nil or as deemed suitable by advisory committee

DESCRIPTION OF COURSES

Undergraduate courses

ENTO. 211 INSECT MORPHOLOGY AND SYSTEMATICS 3 (2+1)

Theory:

History of entomology in India; classification of phylum Arthropoda; relationship of class Insecta with other classes of Arthropoda; insect dominance in nature.

Morphology:

Structure and function of insect cuticle, moulting process; body segmentation, structure of head, thorax and abdomen; structure and modifications of insect antennae, mouth parts and legs; wing venation, modifications and wing coupling apparatus; structure of male and female genitalia; sensory organs; metamorphosis, diapause, hibernation and aestivation; types of larvae and pupae; structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretory and reproductive systems in insects; types of reproduction of insects.

Systematics:

Taxonomy – importance, history and development; binomial nomenclature; definitions of biotype, sub-species, species, genus, family and order; classification of class Insecta to Orders; distinguishing characters of families: Orthoptera–Acrididae; Dictyoptera–Mantidae; Odonata; Isoptera–Termitidae; Thysanoptera–Thripidae.; Hemiptera–Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Aleyrodidae, Pseudococcidae; Neuroptera-Chrysopidae; Lepidoptera–Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae; Coleoptera-Coccinellidae, Chrysomelidae, Cerambycidae, Curculionidae, Bruchidae, Scarabaeidae; Hymenoptera-Tenthridinidae, Apidae, Trichogrammatidae, Ichneumonidae, Braconidae; Diptera–Cecidomyiidae, Trypetidae, Tachinidae, Agromyziidae.

Practical:

Methods of collection and preservation of insects including immature stages; external features of grasshopper; study of modifications 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 families of agricultural importance as in theory.

Suggested Readings:

1. Chapman, R.F. 1974. Insect Structure and Function, ELBS Publishers, New Delhi.
2. Gullan, P.J. and Cranston, P.S. 2005. Insects: an outline of entomology, III edition Chapman & Hall publication.
3. Nayar, K.K., Ananthakrishnan, T.N. and David. B.V. 1976. General and Applied Entomology. McGraw Hill Publishing Co. Ltd., New Delhi.
4. Pant, N.C. and Ghai, S., 1981. Insect Physiology and Anatomy, ICAR.
5. Richards O.W. and Davies, R.G. 1977. Imm's General Text Book of Entomology, Vol. I & II. Chapman and Hall, London.
6. **Romoser, W. S. and Staffolano, W. S. Jr. 1994. The Science of Entomology. III Edition, Winn C. Brown Publishers.**
7. Tembhare, R. D. 2000. Modern Entomology. Himalaya Publishing House, Mumbai.

ENTO. 221 INSECT ECOLOGY AND INTEGRATED PEST MANAGEMENT 3 (2+1)

Theory:

Insect ecology: Introduction, environment and its components; effect of abiotic factors – temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents; effect of biotic factors – food, competition, natural and environmental resistance; concepts of balance of life in nature, biotic potential, environmental resistance and causes of pest outbreaks in agro-ecosystems; pest surveillance and forecasting.

IPM: introduction, importance, concepts and tools of IPM – host plant resistance, cultural, mechanical, physical, legislative, biological (parasites, predators and pathogens such as bacteria, fungi and viruses), chemical methods of control; chemical control–importance, hazards and limitations; botanical insecticides–*neem* based products; classification of insecticides, formulations and their examples; other methods of pest control – repellents, antifeedants, hormones, attractants, gamma radiation and genetic control; practices, scope and limitations of IPM;

Insecticides Act 1968 – important provisions; introduction to pesticide application; phytotoxicity of insecticides; symptoms of poisoning, first aid and antidotes.

Bio-agents: Parasitoids and predators used in pest management and their mass multiplication techniques; important groups of microorganisms – bacteria, viruses and fungi used in pest management and their mass production; major pollinators, weed killers and scavengers – their importance.

Practical:

Visit to meteorological observatory/automatic weather reporting station; study of terrestrial and pond ecosystems of insects; studies on insect behaviour and orientation (repellency, stimulation, deterrence); study of distribution patterns of insects, sampling techniques for the estimation of insect population and damage; pest surveillance through light traps, pheromones traps and field incidence; practicable IPM techniques – mechanical and physical methods, cultural and biological, chemical – insecticides and their formulations; calculation of doses/ concentrations of insecticides.

Suggested Readings:

1. Dhaliwal, G.S. and Ramesh Arora 2001. Integrated Pest Management: concepts and approaches. Kalyani Publishers, New Delhi.
2. Metcalf, R.L. and Luckman, W.H. 1982. Introduction to Insect Pest Management. Wiley Inter Science Publishing, New York.
3. Pedigo, Larry P. 2002. Entomology and Pest Management [IV Edition]. Prentice-Hall of India, New Delhi.
4. Yazdani, G.S. and Agarwal, M.L. 1979. Elements of Insect Ecology. Naroji Publishing House, New Delhi.

ENTO. 311 PESTS OF CROPS, STORED GRAINS AND THEIR MANAGEMENT 3 (2+1)

Theory:

Distribution, biology, nature and symptoms of damage and management strategies of insect and non-insect pests of rice, sorghum, maize, wheat, sugarcane, cotton, mesta, sun hemp, pulses, groundnut, castor, gingerly, safflower, sunflower, mustard, brinjal, bhendi, tomato, cruciferous and cucurbitaceous vegetables, potato, sweet potato, colacasia, drumstick, amaranths, chillies, mango, citrus, grapevine, cashew, banana, pomegranate, guava, sapota, ber, apple, coconut, tobacco, coffee, tea, turmeric, betel vine, onion, coriander, curry leaf, pepper, ginger and ornamental plants; biology, nature of damage and management of stored grain pests: *Sitophilus*, *Trogoderma*, *Rhyzopertha*, *Tribolium*, *Callosobruchus*, *Lasioderma*; *Sitotroga*, *Cadra*, *Corcyra*, *Pthorimea*, *Plodia*.

Practical:

Identification of pests and their damage symptoms of important crops as covered in theory.

Suggested Readings:

1. **Atwal, A. S. and Dhaliwal, G. S. 1997. Agricultural Pests of South Asia and their Management. Kalyani Publishers, Ludhiana.**
2. **Ayyar, T. V. R. 1984. Handbook of Economic Entomology for S. India. Narendra Publishing House, Delhi.**
3. **David. B. V. 2001. Elements of Economic Entomology. Popular Book Depot. Chennai.**
4. **Khare, B. P. 1993. Stored Grain Pests and Their Management. Kalyani Publishers, Ludhiana.**
5. Pedigo, L.P. 2002. Entomology and Pest Management [IV Edition]. Prentice-Hall of India, New Delhi.
6. **Pradhan. S. 1983. Agricultural Entomology & Pest Control. ICAR Publication, New Delhi.**

ENT. 421 INTEGRATED PEST MANAGEMENT 4 (2+2)

Theory:

Introduction, principles, and concept of IPM. Ecological basis of IPM. IPM modules for major crops under open and protected cultivation. Biotechnological approaches and their potential in IPM. Survey and surveillance techniques of important pests and their natural enemies.

Introduction, components of integrated disease management – cultural, chemical, biological and host plant resistance; Development of IDM, IDM of rice, wheat, cotton, maize, bajra, sugarcane, chickpea, mustard and important vegetables and fruits; genetically modified crops.

Practical:

Sampling of pest population utilizing various traps. Monitoring of insect pest, and natural enemies. Concept and calculation of injury levels, estimation of losses, visit of IPM fields in major crops and protected cultivation.

Application of cultural, chemical and biological agents, their compatibility and integration in IDM, demonstration of IDM in *Rabi* (wheat & mustard) / *Kharif* (maize and groundnut) crops.

Suggested readings:

1. David, B.V. 2000. Elements of Entomology. CAB Publications, Chennai.
2. Dhaliwal, G.S. and E.A. Heinrichs. 1998. Critical issues in pest management. Commonwealth Publishers, New Delhi. 287 p.

3. Dhaliwal, G.S. and Ramesh Arora 2002. Integrated Pest Management – Concept and Approaches. Kalyani Publishers, New Delhi, 297 p.
4. Metcalf, R.L. and Luckmann, W.H. 1982. Introduction of Insect Pest Management. A wiley – Interscience Publication, 561 p.
5. Pedigo, L.P. 2002. Entomology and Pest Management. Prentice hall of India, New Delhi.
6. Pradhan, S. 1983. Agricultural Entomology and Pest Control. Indian Council of Agricultural Research, New Delhi, 267 p.
7. Gupta V.K. & Sharma, R.C. (Eds). 1995. Integrated Disease Management and Plant Health. Scientific Publ., Jodhpur.
8. Mayee C.D., Manoharachary C, Tilak KVBR, Mukadam D.S. & Deshpande Jayashree (Eds.). 2004. Biotechnological Approaches for the Integrated Management of Crop Diseases. Daya Publ. House, New Delhi.
9. Sharma, R.C. and Sharma, J.N. (Eds). 1995. Integrated Plant Disease Management. Scientific Publ., Jodhpur.

ENTO. 422 MANAGEMENT OF POST HARVEST INSECT PESTS AND DISEASES 3 (1+2)

Theory:

Common insect pests of stored grains and products. Methods of bag and bulk storage. Qualitative and quantitative grain deterioration and quality control. Origin and source of infestation, prophylactic and curative methods of stored grain pest management. Grain protectants, fumigants, principles of fumigation, common fumigants and their properties.

Common storage molds of grains and mycotoxins; concept of post harvest diseases of fruits and vegetables; principles of disease management in controlling post harvest diseases; types of post harvest problems both by biotic and abiotic causes; factors governing post harvest problems, role of environmental factors, role of bio-control agents and chemical in controlling post harvest diseases; integrated approaches in controlling diseases and improving the shelf life of product.

Practical:

Identification of different storage pests; detection of insect infestation; estimation of grain moisture; analysis of damaged and healthy samples for protein, carbohydrate and fat, bait preparation, disinfestations of bags, use of solar heat treatment machine, grain cleaning and grading machine, fumigation practices and exercises; visit to warehouse/seed corporation, study of different storage structures. Safe storage of pulses using sand.

Isolation and characterization of pathogens, role of different storage conditions on disease development, evaluation of antagonists against pathogens *in vitro*; comparative efficacy of fungicides, phytoextracts and bio-agents.

Suggested Readings:

1. David Rees, 2004. Insects of Stored Products. CSIRO publishing Australia.
2. Entomology in India, 1964. Entomological Society of India, New Delhi.
3. Khare, B.P. 1993. Stored Grain Pests and Their Management. Kalyani Publishers, Ludhiana.
4. Kushwaha, K.S. and Sharma, J.C. 1967. Safe storage of grains and other products from insect pest and rats. Tech. Bulletin, University of Udaipur, Udaipur.
5. Munro, J.W. 1966. Pests of stored products. Hutchinson of London.
6. Pathak, V.N. 1970. Disease of Fruit Crops and their Control. IBH Publ., New Delhi.
7. Chaddha, K.L. and Pareek, O.P. 1992. Advances in Horticulture Vol. IV, Malhotra Publ. House, New Delhi.

ENT. 423 NON-INSECT PESTS AND THEIR MANAGEMENT

3 (1+2)

Theory:

Bio-ecology and management of important phytophagous and storage mites. Mites as vector of plant disease. Economic importance and management of nematodes. Snail and slugs, birds and mammals with special reference to rodents, awareness of wild life act.

Practical:

Identification of important pests, field acquaintance, rearing and collection of mites. Preparation of permanent mounts of phytophagous and stored grain mites. Formulation and field application of acaricides. Management of crop mites, rats, birds, baits and blue bulls.

Suggested readings:

1. Anonymous, 1983. Agricultural Entomology. By All India Scientific Writers Society, New Delhi.
2. Anonymous, 1985. Non-insect pests and predators. All India Scientific Writers Society, New Delhi.
3. E.W. Baker and G.W. Wharton, 1964. An Introduction to Acarology. The MacMillan Company Newyork.
4. M.R.G.K. Nair, 1986. Insects and mites of crops in India, ICAR New Delhi.
5. P.D. Srivastava, 1977. Economic Zoology. Commercial Publication Bureau, New Delhi.

ENT. 424 APICULTURE AND POLLINATORS 2 (0+2)

Theory (basic of bee and pollinator)

Introduction to Apiculture and study of habit, habitat and nesting behaviour of *Apis dorsata, Apis indica, Apis floera, Apis mellifera.* Life cycle, colony organization and division of labour. Bee behaviour and communication. Other pollinators in different agro-cecosystems.

Practicals

Collection and identification of bees and other insect pollinators in different cropping systems. Bee behaviour studies, honey production and food safety certificate, impact of agrochemicals on bees – bee poisoning. Pollination studies and crop improvement due to pollination. Queen bee rearing. Bee enemies and diseases. Bee keeping equipments. Beekeeping and seasonal management. Bee products (collection methods, composition and uses): (a) Honey (b) Wax (c) Venom (d) Propolis (e) Royal jelly (f) Pollen. Management of bee colonies for pollination .

References

Atwal, A.S. 2000. Essentials of Beekeeping & Pollination. Kalyani Publishers.

Dadant and Son, 1975. The hive and the honey bee. Hamilton, Ilinois, USA.

Free J.B. 1977. The social organization of honeybees. Edward Arnold, London.

Free, J.B. 1970. Insect pollination of crops. Academic Press, London.

Peter G. Kevan 1995. The Asiatic hive bee: Apiculture, biology, and role in sustainable development in tropical and subtropical Asia.

Roger A. Morse, 1978. Bee and Bee Keeping, Cornell University Press, London.

Sardar Singh, 1962. Beekeeping in India. Indian Council of Agricultural Research, New Delhi.

ENT. 425 BIOCONTROL AGENTS -THEIR PRODUCTION AND USE 3 (0+3)

Collection and identification of predators and parasitoids in different cropping systems, microbes infecting larvae of insect pests of major crops and immature stages of entomophages of different orders. Predatory and parasitic potential of selected entomophages on different group of insects. Mass rearing techniques of host insects and major Biocontrol agents. Field release of parasitoids and predators and application of pathogens with their assessment. Botanical production techniques and their field application. Visit to National and commercial biocontrol laboratories.

Isolation of resident biocontrol agents from rhizosphere and phyllosphere using selective media and techniques. Identification of major fungal and bacterial biocontrol agents (BCAs). Study of mode of antagonism *in vitro*-mycoparasitism, competition, volatile and diffusible antibiotics. Mass multiplication and formulation of fungal and bacterial antagonists, and study of their shelf life. Application of biocontrol agents - Seed treatment, seedling dip and soil application and economics of application. Monitoring establishment and augmentation of applied BCAs in the rhizosphere and phyllosphere. Enhancing the efficiency of biocontrol agents – integration of fungal and bacterial BCAs (consortia), and with fungicides and botanicals and through inorganic amendments. Quality control system of biocontrol agents. Biological control in IDM, and organic farming,

References:

1. Burges. H.D. (Ed.) 1981. Microbial control of pests and diseases. Academic Press, New York, 949p.
2. Campbell, R. 1989. Biological control of microbial Plant Pathogens. Cambridge University Press, Cambridge, U.K.
3. Coppel, H.C. and J.W. Mertins. 1977. Biological Insect Pest Suppression. Springer – Verlag, Berlin, 314 p.
4. De Bach, P. 1964. Biological control of Insect pests and weeds. Champman and Hall, London, 844 pp.
5. Gautam, R.D. 2008. Biological Pest Suppression. Westville Publishing House, New Delhi, 304 p.
6. Gnanamanickam, S. S. 2002. Biological Control of Crop Diseases. CRC Press, Florida.
7. Hoy, M.A., and Herzag, D.C. 1985. Biological control in Agricultural IPM systems, Academic Press, Orlando.
8. Huffaker, C.B. and Messenger, P.S. 1976. Theory and practice of Biological control. Academic Press, New York, 788 p.
9. Mukherji, K.G. Tewari, G.P., Arora, D. and Saxena, G. 1992. Recent Developments in Biocontrol of Plant Diseases. Aditya Books, New Delhi
10. Pimental, D. 1981. CRC Hand book of Pest management in Agriculture Vol. II CRC Press, Boca Raton Florida.
11. Ridgway, R.L. and S.B. Vinson. 1976. Biological control by augmentation of natural enemies. Plenum Press, New York. 480 p.
12. Tanada, Y and H.K. Kaya, 1992. Insect Pathology, Academic Press. Inc. San Diego. 666 p.

ENT. 426 PESTICIDES AND PLANT PROTECTION EQUIPMENTS 3 (1+2)

Theory:
Introduction, Classification of insecticides, newer insecticidal molecules, Botanical insecticide, Formulations of insecticides, Selection of insecticides. Types of pesticides application equipments: preparation of insecticidal solution, precautions before and after use of pesticides. Safe use of pesticides, pesticides antidotes and plant protection equipment.

History and development of fungicides; definition and related terms, advantages and disadvantages of fungicides; formulations, mode of action and application of different fungicides, Phytotoxicity; compatibility with other agrochemicals and pesticides, factors affecting efficiency of fungicides; fungicidal resistance in plant pathogens and its management.

Practical:
Identification of different types of formulations, equipments, types of duster and sprayers etc. Calibration of pesticide equipments, preparation of desired concentration of insecticides and their application in standing crop, soil application of insecticides against termite and soil inhabitating insects, Application of granular formulation in plant whorls, drenching application of insecticides for the control of termite in standing crop, identification of faults in plant protection equipment and their remedy.

Acquaintance with formulation of fungicides and plant protection appliances; *in vitro* evaluation techniques, preparation of different concentrations of fungicides, compatibility with other chemicals, methods of application of fungicides.

Suggested readings:

1. Bindra, O.S. and Singh, H. 1977. Pesticide-Application Equipment. Oxford and IBH Publishing Co., New Delhi.
2. Bureau of Indian Standard (BIS) 1982. Methods of Test for Manually Operated Sprayers, IS 10134. Indian Standard Institution, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi.
3. H.C.L. Gupta, 1999. Toxicology, Insecticides and Uses. Agrotech. Publishers, Udaipur.
4. Nene, Y.L. and Thapliyal, P.N. 1993. Fungicides in Plant Disease Control. Oxford and IBH New Delhi.
5. Pesticides Association of India. 1989. Manuals for Pesticides Users. Pesticides Association of India, 1202, New Delhi House, 27, Barakhamba Road, New Delhi.
6. S. Pradhan, 1983. Agriculture Entomology and Pest Control. ICAR, New Delhi.

7. Vyas, S.C. 1993. Hand book of Systemic Fungicides. Vol. I, II and III. Tata McGraw Hill Publ. New Delhi.

Postgraduate courses

ENT 511 INSECT MORPHOLOGY AND ANATOMY 3(2+1)

Objective

To acquaint the students with external morphology and internal systems of the insect's body.

Theory

UNIT I

External Morphology: Insect body wall structure, cuticular outgrowths, colouration and special integumentary structures in insects, body tagmata, sclerites and segmentation.

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

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.

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

UNIT II

Internal Systems: Structure and modification of different systems- digestive, circulatory, respiratory, excretory, nervous, sensory, reproductive, musculature, and secretory system.

Practical

Preparation of permanent mounts of different body parts and their appendages of taxonomic importance including male and female genitalia. Dissection of digestive, nervous and reproductive systems of different insects.

Suggested Readings

Chapman RF. 1998. *The Insects: Structure and Function*. Cambridge Univ. Press, Cambridge.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.

Evans JW. 2004. *Outlines of Agricultural Entomology*. Asiatic Publ., New Delhi.

Gillott, C. 1995. *Entomology*, 2nd Ed. Plenum Press, New York, London.

Gullan, P.J. and Cranston, P.S. 2000. *The Insects, An Outline of Entomology*, 2nd Ed. Blackwell Science, U.K.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology*. 10th Ed. Chapman & Hall, London.

Snodgross RE. 1993. *Principles of Insect Morphology.* Cornell Univ. Press, Ithaca.

Tembhore, D.B. 2000. *Modern Entomology*, Himalaya Publishing House, Mumbai.

ENT 512 INSECT PHYSIOLOGY AND NUTRITION 3 (2+1)

Objective

To impart knowledge to the students about physiology of different systems, nutritional physiology and their application in entomology.

Theory

UNIT I

Scope and importance of insect physiology; physiology of integument, moulting; growth, metamorphosis and diapause.

Mechanism of digestion, circulation, respiration, excretion, and impulse transmission in the insects. Physiology of reproductive and secretory systems.

UNIT II

Importance of 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

Chromatographic analysis of free amino acids of haemolymph; determination of chitin in insect cuticle; examination of insect haemocytes; preparation and evaluation of various diets; consumption, utilization and digestion of natural and artificial diets.

Suggested Readings

Chapman RF.1998. *Insects: Structure and Function*. ELBS Ed., London.

Duntson PA. 2004. *The Insects: Structure, Function and Biodiversity*. Kalyani Publ., New Delhi.

Gullan, P.J. and Cranston, P.S. 2000. *The Insects*: *An Outline of Entomology*, 2nd Ed. Blackwell Science, U.K.

Kerkut GA & Gilbert LI. 1985. *Comprehensive Insect Physiology, Biochemistry and Pharmacology.* Vols. I-XIII. Pergamon Press, New York.

Patnaik BD. 2002. *Physiology of Insects*. Dominant, New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Vol. 1. *Structure, Physiology and Development.* Chapman & Hall, New York.

Wigglesworth VB.1984. *Insect Physiology.* 8th Ed. Chapman & Hall, New York.

ENT 513 INSECT TAXONOMY AND CLASSIFICATION 3 (2+1)

Objective

To sensitize the students on the theory and practice of classifying organisms (with special reference to animals) and the rules governing the same. To introduce the students to the classification of insects up to the level of families with hands-on experience in identifying the families of insects.

Theory

UNIT I

Introduction to the history and principles of systematics and its importance. Brief evolutionary history of Insects- introduction to phylogeny of insects and Major Classification of Superclass Hexapoda – Classes – Ellipura (Collembola, Protura), Diplura and Insecta- and the Orders contained. International Code of Zoological Nomenclature, its brief explanation and uses.

UNIT II

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

UNIT III

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

Practical

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

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers*. 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Mayr, E. 1971. *Principles of Systematic Zoology*. Tata McGraw Hill, New Delhi.

Richards OW & Davies RG. 1977. *Imm's General Text Book of Entomology.* 10th Ed. Chapman & Hall, London.

Ross HH.1974. *Biological Systematics.* Addison Wesley Publ. Company.

Triplehorn CA & Johnson NF. 1998. *Borror and DeLong's Introduction to the Study of Insects.* 7th Ed. Thomson/ Brooks/ Cole, USA/Australia.

ENT 521 INSECT ECOLOGY 3 (2+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 indices. Train students in sampling methodology, calculation of diversity indicies, constructing life tables, relating insect population fluctuations to biotic and/or abiotic causes.

Theory

UNIT I

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

UNIT II

Basic concepts of abundance- Model vs Real world. Population growth basic models – Exponential vs Logistic models. Discrete vs Continuous growth models. Concepts of Carrying capacity, Environmental Resistance and Optimal yield. Vital

Statistics- Life Tables and their application to insect biology. Survivorship curves. Case studies of insect life tables. Population dynamics- Factors affecting abundance- Environmental factors, dispersal and migration, Seasonality in insects. Classification and mechanisms of achieving different seasonality- Diapause (Quiescence) - aestivation, hibernation.

UNIT III

Biotic factors- Food as a limiting factor for distribution and abundance, Nutritional Ecology. Food chain- web and ecological succession. Interspecific interactions- Basic factors governing the interspecific interactions- Classification of interspecific interactions - The argument of cost-benefit ratios. Competition- Lotka-Volterra model, Concept of niche ecological homologues, competitive exclusion. Evolution of mimicry, colouration, concept of predator satiation; evolution of life history strategies.

UNIT IV

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

Practical

Types of distributions of organisms. Methods of sampling insects, estimation of densities of insects and understanding the distribution parameters- Measures of central tendencies, Poisson Distribution, Negative Binomial Distribution. Determination of optimal sample size. Learning to fit basic population growth models and testing the goodness of fit. Fitting Holling's Disc equation, Assessment of prey-predator densities from natural systems and understanding the correlation between the two. Assessing and describing niche of some insects of a single guild. Calculation of niche breadth, activity breadth and diagrammatic representation of niches of organisms. Calculation of 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.

Suggested Readings

Chapman JL & Reiss MJ. 2006. *Ecology: Principles & Applications*. 2nd Ed. Cambridge Univ. Press, Cambridge.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics.* Sinauer Associates, Inc., Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology.* 3rd Ed. Sinauer Associates, Inc., Sunderland, MA

Gupta RK. 2004. *Advances in Insect Biodiversity*. Agrobios, Jodhpur.

Krebs CJ. 1998. *Ecological Methodology*. 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001. *Ecology: The Experimental Analysis of Distribution and Abundance.* 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement.* Princeton Univ. Press, Princeton.

Price PW. 1997. *Insect Ecology*. 3rd Ed. John Wiley, New York.

Real LA & Brown JH. (Eds). 1991. *Foundations of Ecology: ClassicPapers with Commentaries*. University of Chicago Press, Chicago.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Methuen & Co. Ltd., London.

Speight MR, Hunta MD & Watt AD. 2006. *Ecology of Insects: Concepts and Application*. Elsevier Science Publ., The Netherlands.

Wilson EO & William H Bossert WH. 1971. *A Primer of Population Biology*. Harvard University, USA.

Wratten SD & Fry GLA.1980. *Field and Laboratory Exercises in Ecology*. Arnold, London.

ENT 522 BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS 3 (2+1)

Objective

To train the students with theory and practice of biological control, mass production techniques and field evaluation of various biological control agents like parasitoids, predators and various entomopathogenic microorganisms.

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

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

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 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.

Suggested Readings

Burges HD & Hussey NW. (Eds). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, New York.

Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and Approaches.* Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual.* Chapman & Hall, New York.

Huffaker CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

Ignacimuthu SS and Jayaraj S. 2003. *Biological Control of Insect Pests*. Phoenix Publ., New Delhi.

Saxena AB. 2003. *Biological Control of Insect Pests*. Anmol Publ., New Delhi.

Van Driesche & Bellows TS. Jr. 1996. *Biological Control*. Chapman &Hall, New York.

ENT 523 TOXICOLOGY OF INSECTICIDES 3 (2+1)

Objective

To orient the students with structure and mode of action of important insecticides belonging to different groups, development of resistance to insecticides by insects, environmental pollution caused by toxic insecticides and their toxicological aspects.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Insecticide metabolism; insect-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; laboratory and field evaluation of bioefficacy of insecticides; bioassay techniques; probit analysis; evaluation of insecticide toxicity. Toxicity to beneficial insects. Pesticide appliances. Working out doses and concentrations of pesticides.

Suggested Readings

Chattopadhyay SB. *1985. Principles and Procedures of Plant Protection.* Oxford & IBH, New Delhi.

Gupta HCL.1999. *Insecticides: Toxicology and Uses.* Agrotech Publ., Udaipur.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.

Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.

Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT 531 PRINCIPLES OF INTEGRATED PEST MANAGEMENT 3 (3+0)

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM**.** Train students in computation of ETL, implementing IPM programmes.

Theory

UNIT I

History and origin, definition and evolution of various related terminologies. Importance of resistance, principles, classification, components, types and mechanisms of resistance.

UNIT II

Concept and philosophy, ecological principles, economic threshold concept, and economic consideration. Insect-host plant relationships; theories and basis of host plant selection in phytophagous insects.

UNIT III

Tools of pest management and their integration- legislative, cultural, physical and mechanical 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.

UNIT IV

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. 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.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* 1st Ed., Springer, New York.

Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and Protected Crops*. Springer, New Delhi.

Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ., New Delhi.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Pedigo RL. 2002. *Entomology and Pest Management.* 4th Ed. Prentice Hall, New Delhi.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 532 PESTS OF FIELD CROPS AND THEIR MANAGEMENT 3 (2+1)

Objective

To familiarize the students about nature of damage and seasonal incidence of insect pests that cause loss to major field crops and their effective management by different methods.

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.

Suggested Readings

Atwal AS, Dhaliwal GS & David BV. 2001. *Elements of Economic Entomology.* Popular Book Depot, Chennai.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Dunston AP. 2007. *The Insects: Beneficial and Harmful Aspects*. Kalyani Publ., New Delhi

Evans JW. 2005. *Insect Pests and their Control*. Asiatic Publ., New Delhi.

Nair MRGK. 1986. *Insect and Mites of Crops in India.* ICAR, New Delhi.

Prakash I & Mathur RP. 1987. *Management of Rodent Pests.* ICAR, New Delhi.

Saxena RC & Srivastava RC. 2007. *Entomology at a Glance*. Agrotech Publ. Academy, Udaipur.

ENT 533 PESTS OF HORTICULTURAL AND PLANTATION CROPS 3 (2+1)

Objective

To impart knowledge on major pests of horticultural and plantation crops regarding the extent and nature of loss, seasonal history, their integrated management.

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, 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.

Suggested Readings

Atwal AS & Dhaliwal GS. 2002. *Agricultural Pests of South Asia and theirManagement.* Kalyani Publ., New Delhi.

Butani DK & Jotwani MG. 1984. *Insects and Vegetables.* Periodical Expert Book Agency, New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essential of Agricultural Entomology.* Kalyani Publ., New Delhi.

Srivastava RP.1997. *Mango Insect Pest Management.* International Book Distr., Dehra Dun.

Verma LR, Verma AK & Goutham DC. 2004. *Pest Management in Horticulture Crops*: *Principles and Practices*. Asiatech Publ., New Delhi.

ENT 534 STORAGE PESTS AND THEIR MANAGEMENT 3 (2+1)

Objective

To focus on requirement and importance of grain and grain storage, to understand the role of stored grain pests and to acquaint with various stored grain pest management techniques for avoiding losses in storage.

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).

Suggesting Readings

Hall DW. 1970. *Handling and Storage of Food Grains in Tropical and Subtropical Areas.* FAO. Agricultural Development Paper No. 90 and FAO, Plant Production and Protection Series No. 19, FAO, Rome.

Jayas DV, White NDG & Muir WE. 1995. *Stored Grain Ecosystem.* Marcel Dekker, New York.

Khader V. 2004. *Textbook on Food Storage and Preservation*. Kalyani Publ., New Delhi.

Khare BP. 1994. *Stored Grain Pests and Their Management.* Kalyani Publ., New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Interrelated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 524 ACAROLOGY AND SOIL ARTHROPODS 3 (2+1)

Objective

To acquaint the students with external morphology of different groups of mites, train in identification of commonly occurring families of plant associated mites, provide information about important mite pests of crops and their management. To impart knowledge about the different groups of arthropods found in soil, interaction between the different groups, and role of soil arthropods in humus formation. Hands-on training in sampling and identification of different groups of soil arthropods.

Theory

UNIT I

History of Acarology; importance of mites as a group; habitat, collection and preservation of mites. Soil arthropods and their classification, habitats and their identification.

UNIT II

Introduction to morphology and biology of mites and ticks. Broad classification-major orders and important families of Acari including diagnostic characteristics. Estimation of populations; sampling and extraction methods for soil arthropods.

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. 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.

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.

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

Suggested Readings

Anderson JM & Ingram JSI. 1993. *Tropical Soil Biology and Fertility: A Handbook of Methods.* CABI, London.

Chhillar BS, Gulati R & Bhatnagar P. 2007. *Agricultural Acarology*. Daya Publ. House, New Delhi.

Dindal DL. 1990. *Soil Biology Guide*. A Wiley-InterScience Publ., John Wiley & Sons, New York.

Gerson U & Smiley RL. 1990. *Acarine Biocontrol Agents - An Illustrated Key and Manual*. Chapman & Hall, NewYork.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.

Gwilyn O & Evans GO. 1998. *Principles of Acarology*. CABI, London.

Jeppson LR, Keifer HH & Baker EW. 1975. *Mites Injurious to Economic Plants*. University of California Press, Berkeley.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State Univ. Book Stores, Corvallis, Oregon.

Pankhurst C, Dube B & Gupta, V. 1997. *Biological Indicators of Soil Health.* CSIRO, Australia.

Qiang Zhiang Z. 2003. *Mites of Green Houses- Identification, Biology and Control*. CABI, London.

Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi.

Walter DE & Proctor HC. 1999. *Mites- Ecology, Evolution and Behaviou*r. CABI, London.

Veeresh GK & Rajagopal D.1988. *Applied Soil Biology and Ecology*. Oxford & IBH Publ., New Delhi.

ENT 525 INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS 3 (2+1)

Objective

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

Theory

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.

Suggested Readings

Basu AN. 1995. *Bemisia tabaci* (Gennadius) - *Crop Pest and Principal Whitefly Vector of Plant Viruses.* Oxford & IBH, New Delhi.

Harris KF & Maramarosh K. (Eds.).1980. *Vectors of Plant Pathogens*. Academic Press, London.

Maramorosch K & Harris KF. (Eds.). 1979. *Leafhopper Vectors and Plant Disease Agents*. Academic Press, London.

Youdeovei A & Service MW. 1983. *Pest and Vector Management in the Tropics*. English Language Books Series, Longman, London.

ENT 528 PLANT QUARANTINE 2 (2+0)

Objective

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

Theory

UNIT I

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

UNIT II

Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT III

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

UNIT IV

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

Suggested Readings

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM*. Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

ENT 535 COMMERCIAL ENTOMOLOGY 3 (2+1)

Objective

To familiarize the students with entrepreneurial opportunities in entomology, provide information on productive insects and their products, as well as insect pests of public health and veterinary importance and their management.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

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

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

Suggested Readings

Aruga H. 1994. *Principles of Sericulture*. Oxford & IBH, New Delhi.

Atwal AS. 2006. *The World of the Honey Bee*. Kalyani Publ., New Delhi.

Ganga G. 2003. *Comprehensive Sericulture.* Vol. II. *Silkworm Rearing and Silk Reeling*. Oxford & IBH, New Delhi.

Partiban S & David BV. 2007. *Management of Household Pests and Public Health Pests*. Namratha Publ., Chennai.

Singh S. 1975. *Beekeeping in India*. ICAR, New Delhi.

ENT 621 MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH 2 (1+1)

(Compulsory Course)

Objective

To familiarize the students with DNA recombitant techonology, marker genes, transgenic plants, biotechnology in sericulture and apiculture.

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. 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.

Suggested Readings

Bhattacharya TK, Kumar P & Sharma A. 2007. *Animal Biotehnology*. 1st Ed., Kalyani Publ., New Delhi.

Hagedon HH, Hilderbrand JG, Kidwell MG & Law JH. 1990. *Molecular Insect Science.* Plenum Press, New York.

Oakeshott J & Whitten MA.. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer Verlag.

Rechcigl JE & Rechcigl NA. 1998. *Biological and Biotechnological Control of Insect Pests.* Lewis Publ., North Carolina.

Roy U & Saxena V. 2007. *A Hand Book of Genetic Engineering*. 1st Ed., Kalyani Publ., New Delhi.

Singh BD. 2008. *Biotechnology (Expanding Horizons)*. Kalyani Publ., New Delhi.

Singh P. 2007. *Introductory to Biotechnology*. 2nd Ed. Kalyani Publ., New Delhi.

ENT 611 ADVANCED INTEGRATED PEST MANAGEMENT

2 (2+0)

(Compulsory Course)

Objective

To acquaint the students with recent concepts of integrated pest management. Surviellance and data base management. Successful national and international case histories of integrated pest management, non-conventional tools in pest management.

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' real time 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.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Singh R & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* Springer, Berlin.

Koul O & Cuperus GW. 2007. *Ecologically Based Integrated Pest Management.* CABI, London.

Koul O, Dhaliwal GS & Curperus GW. 2004. *Integrated Pest Management – Potential, Constraints and Challenges.* CABI, London.

Maredia KM, Dakouo D & Mota-Sanchez D. 2003. *Integrated Pest Management in the Global Arena.* CABI, London.

Metcalf RL & Luckman WH. 1982. *Introduction of Insect Pest Management.* John Wiley & Sons, New York.

Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concept in Integrated Pest Management.* Prentice Hall, New Delhi.

Pedigo RL. 1996. *Entomology and Pest Management.* Prentice Hall, New Delhi.

Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

ENT 612 ADVANCED INSECT SYSTEMATICS 3 (1+2)

(Core Course)

Objective

To familiarize the students with different schools of classification, phylogenetics, classical and molecular methods, evolution of different groups of insects. Detailed study about the International Code of Zoological Nomenclature; ethics and procedure for taxonomic publications.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

Concept of Phylocode and alternative naming systems for animals. A detailed study of selected representatives of taxonomic publications – small publications of species descriptions, works on revision of taxa, 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, and 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 polarization for developing cladograms and use of computer programmes to develop cladograms.

Suggested Readings

CSIRO 1990. *The Insects of Australia: A Text Book for Students and Researchers.* 2nd Ed. Vols. I & II, CSIRO. Cornell Univ. Press, Ithaca.

Dakeshott J & Whitten MA. 1994. *Molecular Approaches to Fundamental and Applied Entomology.* Springer-Verlag, Berlin.

Freeman S & Herron JC. 1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Hennig W. 1960. *Phylogenetic Systematics*. Urbana Univ. Illinois Press, USA.

Hoy MA. 2003. *Insect Molecular Genetics: An Introduction to Principles and Applications*. 2nd Ed. Academic Press, New York.

Mayr E & Ashlock PD. 1991. *Principles of Systematic Zoology.* 2nd Ed. McGraw Hill, New York.

Mayr E.1969. *Principles of Systematic Zoology.* McGraw-Hill, New York.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy.* Blackie Academic and Professional, London.

Ross HH. 1974. *Biological Systematics.* Addison Wesley Publ. Co., London.

Wiley EO. 1981. *Phylogenetics: The Theory and Practices of Phylogenetic Systematics for Biologists*. Columbia Univ. Press, USA.

ENT 613 ADVANCED INSECT PHYSIOLOGY AND BEHAVIOUR 3 (2+1)

(Core Course)

Objective

To impart knowledge to the students on detailed physiology of various secretory and excretory systems, moulting process, chitin synthesis, physiology of digestion, transmission of nerve impulses, nutrition of insects, pheromones etc.

Theory

UNIT I

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

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, polymorphism and diapause. Insect 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 inpest management.

Practical

Demonstration of the use of different techniques – (a). Electrophoretic (b) Chromatography (c) Spectrophotometry (d) Olfactometer

Suggested Readings

Ananthkrishnan TN. (Ed.). 1994. *Functional Dynamics of Phytophagous Insects*. Oxford & IBH, New Delhi.

Awasthi VB. 2001. *Principles of Insect Behaviour*. Scientific Publ., Jodhpur.

Bernays EA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects*. Chapman & Hall, London.

Brown LB. 1999. *The Experimental Analysis of Insect Behaviour.* Springer, Berlin.

Kerkut GA & Gilbert LI. 1985. *Insect Physiology, Biochemistry and Pharmacology*. Vols. I-XIII. Pergamon Press, Oxford, New York.

Krebs JR & Davies NB. 1993. *An Introduction to Behavioural Ecology.* 3rd Ed. Chapman & Hall, London.

Manning A & Dawkins MS. 1992. *An Introduction to Animal Behaviour*. Cambridge University Press, USA.

Mathews RW & Mathews JR. 1978. *Insect Behaviour.* A Wiley-Inter Science Publ. John Wiley & Sons, New York.

Muraleedharan K. 1997. *Recent Advances in Insect Endocrinology*. Assoc. for Advancement of Entomology, Trivandrum, Kerala.

Rockstein, M. 1978. *Biochemistry of Insects*, Academic Press

ENT 614 ADVANCED INSECT ECOLOGY 2 (1+1)

Objective

To impart advanced practical knowledge of causal factors governing the distribution and abundance of insects and the evolution of ecological characteristics.

Theory

UNIT I

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

UNIT II

Insect Plant Interactions. Fig-figwasp mutualism and a quantitative view of types of Associations. Role of insects in the environment. Adaptations to terrestrial habitats. Evolution of Insect diversity and role of phytophagy as an adaptive zone for increased diversity of insects. Evolution of resource harvesting organs, resilience of insect taxa and the sustenance of insect diversity- role of plants. Herbivory, pollination, predation, parasitism. Modes of insect-plant interaction, tri-trophic interactions. Evolution of herbivory, monophagy vs polyphagy. Role of plant secondary metabolites. Host seeking behaviour of parasitoids. Meaning of stress- plant stress and herbivory. Consequences of herbivory to plant fitness and response to stress. Constitutive and induced plant defenses.

UNIT III

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

UNIT IV

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

Practical

Methods of data collection under field conditions. Assessment of distribution parameters, Taylor's power law, Iwao's patchiness index, Index of Dispersion, etc.

Calculation of sample sizes by different methods. Fitting Poisson and Negative Binomial distributions and working out the data transformation methods. Hardy-Weinberg Law, Computation of

Allelic and Phenotypic Frequencies - Calculation of changes under selection, Demonstration of genetic drift. Assessment of Patch Departure rules. Assessment of Resource size by female insects using a suitable insect model, fruit flies/*Goniozus*/Female Bruchids etc.- A test of reproductive effort and fitness. Construction of Life tables and application of Leslie Matrix – population projections, Stable age distribution. Exercises in development of Algorithms for crop modeling.

Suggested Readings

Barbosa P & Letourneau DK. (Eds.). 1988. *Novel Aspects of Insect-Plant Interactions*. Wiley, London.

Elizabeth BA & Chapman RF. 1994. *Host-Plant Selection by Phytophagous Insects.* Chapman & Hall, New York.

Freeman S & Herron JC.1998. *Evolutionary Analysis*. Prentice Hall, New Delhi.

Gotelli NJ & Ellison AM. 2004. *A Primer of Ecological Statistics*. Sinauer Associates, Sunderland, MA.

Gotelli NJ. 2001. *A Primer of Ecology*. 3rd Ed., Sinauer Associates, Sunderland, MA, USA.

Krebs C. 1998. *Ecological Methodology.* 2nd Ed. Benjamin-Cummings Publ. Co., New York.

Krebs CJ. 2001 *Ecology: The Experimental Analysis of Distribution and Abundance*. 5th Ed. Benjamin-Cummings Publ. Co., New York.

Magurran AE. 1988. *Ecological Diversity and its Measurement*. Princeton University Press, Princeton.

Real LA & Brown JH. (Eds.). 1991. *Foundations of Ecology: Classic Papers with Commentaries.* University of Chicago Press, USA.

Southwood TRE & Henderson PA. 2000. *Ecological Methods.* 3rd Ed. Wiley Blackwell, London.

Strong DR, Lawton JH & Southwood R. 1984. *Insects on Plants: Community Patterns and Mechanism*. Harward University Press, Harward.

Wratten SD & Fry GLA. 1980. *Field and Laboratory Exercises in Ecology*. Arnold Publ., London.

ENT 622 RECENT TRENDS IN BIOLOGICAL CONTROL 3 (2+1)

Objective

To appraise the students with advanced techniques in handling of different bioagents, modern methods of biological control and scope in cropping system-based pest management in agro-ecosystems.

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 semio-chemicals 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.

Suggested Readings

Burges HD & Hussey NW. (Eds.). 1971. *Microbial Control of Insects and Mites.* Academic Press, London.

Coppel HC & James WM. 1977. *Biological Insect Pest Suppression.* Springer Verlag, Berlin.

De Bach P. 1964. *Biological Control of Insect Pests and Weeds.* Chapman & Hall, London.

Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents – An Illustrated Key and Manual*. Chapman & Hall, New York.

Huffakar CB & Messenger PS. 1976. *Theory and Practices of Biological Control.* Academic Press, London.

ENT 623 ADVANCED INSECTICIDE TOXICOLOGY 3 (2+1)

Objective

To acquaint the students with the latest advancements in the field of insecticide toxicology, biochemical and physiological target sites of insecticides, and pesticide resistance mechanisms in insects.

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; 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.

Suggested Readings

Busvine JR. 1971. *A Critical Review on the Techniques for Testing Insecticides.* CABI, London.

Dhaliwal GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.

Hayes WJ & Laws ER. 1991. *Handbook of Pesticide Toxicology.* Academic Press, New York.

Ishaaya I & Degheele (Eds.). 1998. *Insecticides with Novel Modes of Action.* Narosa Publ. House, New Delhi.

Matsumura F. 1985. *Toxicology of Insecticides.* Plenum Press, New York.
O' Brien RD. 1974. *Insecticides Action and Metabolism.* Academic Press, New York.
Perry AS, Yamamoto I, Ishaaya I & Perry R. 1998. *Insecticides in Agriculture and Environment.* Narosa Publ. House, New Delhi.
Prakash A & Rao J. 1997. *Botanical Pesticides in Agriculture.* Lewis Publ., New York.

ENT 624 ADVANCED ACAROLOGY 2 (1+1)

Objective

To acquire a good working knowledge of identification of economically important groups of mites up to the species level, a detailed understanding of the newer acaricide molecules and utilization of predators.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

Practical

Identification of commonly occurring mites up to species, preparation of keys for identification. Collection of specific groups of mites and preparing their identification keys. Rearing phytoseiid mites and studying their role in suppression

of spider mites. Management of mite pests of crops using acaricides, phytoseiid predators, fungal pathogens *etc.*

Suggested Readings

Evans GO.1992. *Principles of Acarology.* CABI, London.

Gerson H & Smiley RL. 1990. *Acarine Biocontrol Agents- An Illustrated Key and Manual*. Chapman & Hall, New York.

Gupta SK. 1985. *Handbook of Plant Mites of India.* Zoological Survey of India, Calcutta.

Krantz GW. 1970. *A Manual of Acarology.* Oregon State University Book Stores, Corvallis, Oregon.

Sadana GL. 1997. *False Spider Mites Infesting Crops in India.* Kalyani Publ. House, New Delhi.

Course Structure – at a Glance

S. No.	Course Numbers	Course Titles	Credit Load
GRADUATE PROGRAMME:			
1.	ENT. 211	INSECT MORPHOLOGY AND SYSTEMATICS	3 (2 + 1)
2.	ENT. 221	INSECT ECOLOGY AND IPM	3 (2 + 1)
3.	ENT. 311	PESTS OF CROPS, STORED GRAINS AND THEIR MGT.	3 (2 + 1)
MASTER'S PROGRAMME:			
1.	ENT. 511**	INSECT MORPHOLOGY AND ANATOMY	3 (2 + 1)
2.	ENT. 512**	INSECT PHYSIOLOGY AND NUTRITION	3 (2 + 1)
3.	ENT. 513**	INSECT TAXONOMY AND CLASSIFICATION	3 (2 + 1)
4.	ENT. 521	INSECT ECOLOGY	3 (2 + 1)
5.	ENT. 522	BIOLOGICAL CONTROL OF CROP PESTS AND WEEDS	3 (2 + 1)
6.	ENT. 523	TOXICOLOGY OF INSECTICIDES	3 (2 + 1)
7.	ENT. 524	ACAROLOGY AND SOIL ARTHROPODS	3 (2 + 1)
8.	ENT. 528#	PLANT QUARANTINE	2 (2 + 0)
9.	ENT. 525	INSECT VECTORS OF PLANT VIRUSES AND OTHER PATHOGENS	2 (1 + 1)

10.	ENT. 531**	PRINCIPLES OF INTEGRATED PEST MANAGEMENT	3 (3 + 0)
11.	ENT. 532	PESTS OF FIELD CROPS AND THEIR MANAGEMENT	3 (2 + 1)
12.	ENT. 533	PESTS OF HORTICULTURAL AND PLANTATION CROPS	3 (2 + 1)
13.	ENT. 534	STORAGE PESTS AND THEIR MANAGEMENT	3 (2 + 1)
14.	ENT. 535	COMMERCIAL ENTOMOLOGY	3 (2 + 1)
15.	ENT. 541	COMPREHENSIVE	Non-credit
16.	ENT. 591	CREDIT SEMINAR	01
17.	ENT. 599	RESEARCH	20
DOCTORAL PROGRAMME:			
1.	ENT. 611*	ADVANCED INTEGRATED PEST MANAGEMENT	2 (2 + 0)
2.	ENT. 612**	ADVANCED INSECT SYSTEMATICS	3 (1 + 2)
3.	ENT. 613**	ADVANCED INSECT PHYSIOLOGY AND BEHAVIOUR	3 (2 + 1)
4.	ENT. 614	ADVANCED INSECT ECOLOGY	2 (2 + 0)
5	ENT. 621*	MOLECULAR APPROACHES IN ENTOMOLOGICAL RESEARCH	2 (1 + 1)
6.	ENT. 622	RECENT TRENDS IN BIOLOGICAL CONTROL	3 (2 + 1)
7.	ENT. 623	ADVANCED INSECT TOXICOLOGY	3 (2 + 1)
8.	ENT. 624	ADVANCED ACAROLOGY	2 (1 + 1)
9.	ENT. 641	COMPREHENSIVE	Non-credit
10.	ENT. 691	CREDIT SEMINAR	02
11.	ENT. 699	RESEARCH	45
COMPULSORY NON-CREDIT COURSES (Across Departments)			
1.	PGS 501	TECHNICAL WRITING AND COMMUNICATION SKILLS	1 (0 + 1)
2.	PGS 503	INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE	1 (1 + 0)
3.	PGS 506	DISASTER MANAGEMENT	1 (1 + 0)

The course* ENT 621 *shall require collaboration with Department of Molecular Biology & Biotechnology

 # This course shall be conducted jointly with the services of a Plant Pathology Expert

** refers to Compulsory Courses; ** refers to Core Courses*

S. No.	Course No.	Title	Credit hours
1	ENT. 421	Integrated Pest Management	4 (2+2)
2	ENT. 422	Management of Post Harvest Insect-pests and Diseases	3 (1+2)
3	ENT. 423	Non-insect Pests and Their Management	3 (1+2)
4	ENT. 424	Apiculture and Pollinators	2 (0+2)
5	ENT. 425	Bio-control Agents- their Production and Uses	3 (0+3)
6	ENT. 426	Pesticides and Plant Protection Equipments	3 (1+2)

ORGANIZATION OF COURSE CONTENTS & CREDIT REQUIREMENTS

Code Numbers

• All courses are divided into two series: 500-series courses pertain to Master's level, and

600-series to Doctoral level. A Ph. D. student must take a minimum of two 600 series courses, but may also take 500-series courses if not studied during Master's programme.

• Credit seminar for Master's level is designated by code no. 591, and the two seminars for Doctoral level are coded as 691.

• Similarly, 599 and 699 codes have been given for Master's research and Doctoral research, respectively.

Course Contents

The contents of each course have been organized into:

• Objective – to elucidate the basic purpose.

• Theory units – to facilitate uniform coverage of syllabus for paper setting.

• Suggested Readings – to recommend some standard books as reference material. This does not unequivocally exclude other such reference material that may be recommended according to the advancements and local requirements.
• A list of journals pertaining to the discipline is provided at the end which may be useful as study material for 600-series courses as well as research topics.
• E-Resources - for quick update on specific topics/events pertaining to the subject.
• Broad research topics provided at the end would facilitate the advisors for appropriate research directions to the PG students.

Minimum Credit Requirements

Subject	**Master's Programme**	**Doctoral Programme**
Major	27	18
Minor & Supporting	09	09
Seminar	01	02
Research	20	45
Total Credits	**57**	**74**

Major subject: The subject (department) in which the students takes admission
Minor subject: The subject closely related to students major subject (Plant Pathology &
Nematology).
Supporting subject: The subject not related to the major subject. It could be any subject considered relevant for student's research work.
Non-Credit Compulsory Courses: Six courses (PGS 501-PGS 506) are of general nature and are compulsory for Master's programme; Ph. D. students may be exempted from these courses if already studied during Master's degree.

DEPARTMENT OF HORTICULTURE

PROGRAMMES

1. M.Sc.
2. Ph.D.

COURSE REQUIREMENTS

M.Sc.

Field of specialization	Field crops, Vegetable Science, Floriculture, Tuber crops, Medicinal and Aromatic Plants.

Core courses	Hort 511, Hort 512, Hort 513, Hort 531
Optional courses	Hort 514, Hort 515, Hort 516, Hort 521, Hort 522, Hort 523, Hort 532, Hort 533,
Minor & supporting courses	Stat 511, Stat 521, Pphys 521 or as per decision of advisory committee in view of research problem
Deficiency courses	Nil or as deemed suitable by advisory committee

Ph.D.

Field of specialization	Field crops, Vegetable Science, Floriculture, Tuber crops, Medicinal and Aromatic Plants.
Core courses	Hort 611, Hort 612,
Optional courses	Hort 621, Hort 622, Hort 623, Hort 624,
Minor & supporting courses	Stat 612, Stat 622, Pphys 522 or as per decision of advisory committee in view of research problem
Non credit compulsory courses	PGS 502, PGS 503 (Exempted if done in M.Sc.)
Deficiency courses	Nil or as deemed suitable by advisory committee

DESCRIPTION OF COURSES

Undergraduate courses

HORT-111 PRODUCTION TECHNOLOGY OF FRUIT CROPS 3(2+1)

Theory:

Definition and importance of horticulture. Divisions of horticulture. Climatic zones of horticulture crops. Area and production of different fruit crops. Selection of site, fencing and wind break planting systems (including high density planting), planning and establishment methods. Propagation methods and use of rootstocks. Methods of training and pruning. Use of growth regulators in fruit production. Package of practices for the cultivation of Major fruits – mango, banana, citrus, grape, guava, sapota, apple, litchi, papaya. Minor Fruits – aonla, pineapple, annonaceous fruits, pomegranate, ber, fig, phalsa, jack, pear, plum, peaches and cherry.

Practical:

Study horticulture tools and implements and their uses. Containers, potting mixture, potting, depotting and repotting. Plant propagation – seed propagation, scarification and stratification. Propagation by cutting (soft wood, hard wood and semi-hard wood) layering (simple layering, air layering, stooling in guava). Layout and planting systems (Traditional system and High density planting method), grafting (vineer grafting, cheft and softwood grafting of mango). Methods of pruning and training. Training of ber, grape and pomegranate. Budding (patch budding and 'T' budding in ber, aonla, guava and citrus). Pruning of ber, grape, phalsa, fig, apple, pear, peach. Description and identification of varieties of banana citrus (lime, lemon, sweet orange, mandrin, grape fruit), pomegranate, ber, pear and cherries. Irrigation methods in fruit crops including drip – Micro irrigation methods of establishment of orchard. Methods of Fertiliser application in fruit crops including fertigation technology. Visit to local commercial orchards. Preparation of growth regulators power, solution and lanolin paste for propagation. Application of growth regulators for improving fruit set, fruit size, quality, delaying repening and hastening ripening.

Suggested Readings:

1. Bal, J.S. 1970. Fruit Production. Kalyani Publishers, New Delhi
2. Naik, K.C. 1967. South Indian Fruits and their culture. Naya Prokash, Calcutta
3. Bose, T.K. and Mitra S.K. 1990. Fruits of India Tropical and Sub-tropical. Naya Prokash, 206, Bidhan Sarni, Calcutta
4. Shanmugavelu, K.G. 1987. Production technology of fruit crops. SBA Publication, 1/1 Meredith Street, Calcutta
5. Polhamus, L.G. 1962. Rubber, Longman, London
6. Chadha, K.L. 2001. Handbook of horticulture. Indian Council of Agricultural Research, New Delhi

HORT-211 PRODUCTION TECHNOLOGY OF VEGETABLES AND FLOWERS 3(2+1)

Theory:

Importance of Olericulture, vegetable gardens, vegetable classification. Origin, area, production, varieties, package of practices of fruit vegetables- tomato, brinjal, chillies and okra; Cucurbitaceous vegetables cucumber, ridge gourd, ash gourd, snake gourd, bottle gourd, bitter gourd and melons, Cole crops – cabbage, cauliflower and knoll-khol. Bulb crops – onion and garlic. Beans and peas – French beans, cluster beans, dolichos beans, peas and cowpea. Tuber crops – potato, sweet potato, tapica, colocasia, yams; Root crops – carrot, radish, turnip and beet root; Leafy vegetables – amaranthus, palak; Perennial vegetables – drumstick, coccinia and curry leaf. Importance of ornamental gardens. Planning of ornamental gardens. Types and styles of ornamental gardens. Use of trees, shrubs, climbers, palms, houseplants and seasonal flowers in the gardens. Package of practices for rose, jasmine, chrysanthemum, marigold, tuberose, gladiolus and gaillardia. Introduction to protected cultivation practices of important vegetable (Cucumber, Capsicum and Tomato) flower crops (Rose, Gerbera and Carnation).

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, house plants, palms etc. and development of garden features; transplanting of vegetable seedling in main field; Layout of lawns and maintenance; Seed extraction in tomato and brinjal; Depotting, repotting and maintenance of house plants; Visit to commercial vegetable farms; Training and

pruning of rose standards, hybrid 'T' roses cented roses and chrysanthemum pinching and disbudding; Planning and layout of gardens and garden designs for public and private areas; Intercultural operations in vegetable crops; Grading and packing of vegetables; Prolonging the shelf life of cut flowers.

Suggested Readings:

1. Choudhary, B. 1985. Vegetables. National Book Trust India, New Delhi
2. Chouhan, D.V.S. 1965. Vegetable Production of India. Kalyani Publisher, Agra (UP)
3. Singh, S.P. 1989. Production Technology of Vegetable Crops. Agricultural Research Communication Centre, Karnal
4. Katyal, S.L. and Chadha, K.L. 1985. Vegetable growing in India. Oxford and IBH Publishing Co., New Delhi
5. Arora, J.S. 1998. Introductory Ornamental Horticulture. Kalyani Publishers, Ludhiana
6. Bose, T.K. and Yadav, L.A. 1988. Commercial Flowers. Naya Prokash, Calcutta
7. Randhawa G.S. and Mukhopadhya, A. 1984. Floriculture in India. Allied Publishers, New Delhi
8. Swaroop V.S. 1984. Flowers. National Book Trust, India
9. Prakash, J. and Bhandari K.R. 1994. Floriculture Technology, Traders & Trends. Oxford and IBH Publishing Co. Pvt. Ltd.

HORT-221 PRODUCTION TECHNOLOGY OF SPICES, AROMATIC 3(2+1)

MEDICINAL AND PLANTATION CROPS

Theory:

Importance and cultivation technology of Spices – ginger, turmeric, pepper, cardamom, coriander, cumin, fenugreek, fennel; Aromatic crops – lemon grass, citronella, palmrose, vetiver, geranium, dawana, Mentha, Damask rose; Plantation crops – coconut, arecanut, betevine, cashew, cocoa, coffee, oilpalm; Medicinal Plants – diascoria, rauvolfia, opium, ocimum, perwinkle, aloe, guggul, belladonna, nuxvomica, *Solanum khasiamum,* senna, plantago, stevia, coleus and lawsonia.

Practical:

Botanical description and identification of aromatic plants; Identification of varieties in spices and plantation crops; Identification of medicinal plants; Propagation techniques in aromatic and spice crops; Selection of mother palm and seed nuts in coconut and oil palm; Study of identification of aromatic plants; Distillation procedures for aromatic crops; Propagation methods in plantation crops; Propagation and planting methods in turmeric; Propagation and planting techniques in ginger, preparation of field and sowing of seed spices. Harvesting and grading of seed spices; Harvesting procedures in aromatic plants; Processing and curing of spices (ginger, turmeric and black pepper); Training methods in betel vine; Products – byproducts of spices and plantation crops; Procedures for oleresin extraction; Visit to local commercial plantations, Aromatic & medicinal plant nurseries and seed spices field.

Suggested Readings:

1. Child, R. 1966. Coconuts. Longmans, London
2. Hearer, A.E. 1971. Coffee growing. Oxford University Press, London
3. Menon, K.P.V. and Pandlai, K.H. 1957. The coconut palms. Indian Central Coconut Committee, Emarkulam, Kerala
4. Nair, M.N.C; Rao Bhaskara; Nambisans, K.K.N. and Nambisan, M.C. 1979. Cashew – A Monograph, CPCRI, Kassargod
5. Polhamus, L.G. 1962. Rubber, Longman, London
6. Chadha, K.L. 2001. Handbook of horticulture. Indian Council of Agricultural Research, New Delhi
7. Purthi, J.S. 2001. Major Spices. Indian Council of Agriculture Research, New Delhi
8. Sen, N.L., Dashora, L.K. and Dashora, A. 2003. Ropen Phaslein, Masalein, Sughandit avem Aushadhyia Poudhay. Alka Publication, Ajmer (Raj.)

HORT-311 POST HARVEST MANAGEMENT AND VALUE ADDITION OF FRUITS AND VEGETABLES 2(1+1)

Theory:

Importance of post harvest in horticultural crops. Maturity indices, harvesting and post harvest handling of fruits and vegetables. Maturity and ripening process. Factors affecting ripening of fruits and vegetables. Pre harvest factors affecting quality on post harvest shelf life of fruits and vegetables. Factors responsible for detioration of harvested fruits and vegetables. Chemicals used for

hastening and delaying ripening of fruits and vegetables. Methods of storage – precooling, prestorage treatments, low temperature storage, controlled atmospheric storage, hypobaric storage, irradiation and low cost storage structures. Various methods of packing for export of mango, banana, grapes kinnow, sweet orange and mandarin etc. Importance and scope of fruit and vegetable preservation in India. Principles of preservation by heat, low temperature, chemicals and fermentation. Unit layout – selection of site and precautions for hygienic conditions of the unit. Preservation through canning, bottling, freezing, dehydration, drying, ultraviolet and ionizing radiations. Preparation of jams, jellies, marmalades, candies, crystallized and glazed fruits, preserves, chutneys, pickles, ketchup, sauce, puree, syrups, juices, squashes and cordials. Spoilage of canned products, biochemical, enzymatic and microbial spoilage. Preservatives, Colours permitted and prohibited in India.

Practical:

Practice in judging the maturity of various fruits and vegetables. Conservation of zero energy cool chambers for on farm storage. 3&4. Determination of physiological loss in weight (PLW), total soluble solids (TSS), total sugars, acidity and ascorbic and content in fruits and vegetables. Packing methods and types of packing and importance of ventilation. Pre cooling packing methods for export or international trade. Methods of prolonging storage life. Effect of ethylene on ripening of banana, sapota, mango. Identification of equipment and machinery used is preservation of fruits and vegetables. Preservation by drying and dehydration. Preparation of jam, jelly and marmalades. Preparation of squash, cordials and syrups. Preparation of chutnerys, pickles sauces and ketchup. Visit to local processing units. Visit to local market yards and cold storage units. Visit to local market and packing industries.

Suggested Readings:

1. Lal, G.; Siddappa, G.S. and Tandon, G.L. 1967. Fruit and Vegetable preservation. ICAR publication
2. Cruess, W.V. 1958. Commercial fruit and vegetable products. Mc Grew-Hill Book Co. Inc., New York

EXPERIENTIAL LEARNING PROGRAMME

HORT-423 Commercial Flower Production 3(1+2)

THEORY

Importance, present status, scope and constraints of Commercial Floriculture in India. Production, post harvest and plant protection technology of commercial flower production viz. Roses, Chrysanthemum, Jasmine, Gladiolus, Tuberose, Statice, Gaillardia, Carnation and Gerbera. Production of F_1 hybrid seed. Quality standard for export of important flowers.

PRACTICAL

i) Identification of commercial flower crops.
ii) Demonstration of commercial propagation methods in chrysanthemum.
iii) Raising of seedling and transplanting of ornamental annuals.
iv) To demonstrate promising rootstock for cut roses.
v) Lifting of tuberose bulbs, curing and bulb treatment break dormancy .
vi) Planting are fertilization in tuberose.
vii) Post harvest handling of Gladiolus and tuberose.
viii) Drying of flowers.
ix) Lifting & storage of gladiolus corms
x) Use of holding solution in cut flower.

HORT-424 Nursery Management of Horticulture Crops 3(0+3)

THEORY

Present status and future scope of nurseries. Recent trends in planning and layout of nurseries and progeny orchard. Principles and method of propagation by seed, cutting, layering, grafting, budding, tissue culture and other physiology of seed, cutting, layering and grafting propagation etc. Use of PGRs and polythene in nursery. Propagation structures like mist chamber, poly house, low tunnel and study of bottom heating technique in cuttings. Economics of raising nursery.

PRACTICAL

i) Identification of propagation material and equipment.

ii) Layout of management of nurseries of progeny orchard.

iii) Multiplication of plants by sexual methods or raising of seedlings.

iv) Propagation by cuttings in Horticulture crops.

v) Propagation by buddings in Horticulture crops

vi) Propagation by graftings in Horticulture crops

vii) Use of plant growth regulators in propagation.

viii) Potting, repotting or lifting of saplings (packaging).

ix) Use of propagation media

x) Use of tetrazolium salt test for germination.

xi) Visit of commercial nurseries.

xii) Project preparation for nursery

xiii) Nursery regulation certification

xiv) Procurement of inputs

xv) Techniques of environment management for large scale production

xvi) Care of nursery plant and management of insect, pest and disease.

xvii) Visit to commercial orchard and diagnosis of maladies.

SUGGESTED READINGS

1. Bose, T.K. Mitra, SK and Sandhu MK (1986). Propagation of tropical & sub-tropical horticultural crops, Naya Prakash, Calcutta.
2. Hartman, HT and Kester, DE (1986). Plant propagation principles and practices. Prentice Hall of India Pvt. Ltd., Bombay
3. Gill, SS. Bal, JS and Sadhu, AS (1985). Raising Fruit Nursery, Kalyani Publishers, New Delhi.

COURSE NO. HORT 427

TITLE: POSTHARVEST TECHNOLOGY OF HORTICULTURAL CROPS

CREDIT HOURS: 0+3

Practical:

1. Determination of maturity indices in fruits, vegetables and flowers of the region (2)

2. Different precooling practices (2)
3. Demonstration of precooling chambers, cold storages and ripening rooms (1)
4. Comparative economics of different cold storage systems (1/2)
5. Construction of Zero Energy Cool Chambers (1)
6. Storage conditions recommended for selected commodities – fruits, vegetables and flowers (1/2)
7. Temperature compatibility groups for storage and retail marketing of fresh fruits, vegetables and flowers (1/2)
8. Pallet layout and stacking options (1/2)
9. Use of temperature recording devices – Maximum & Minimum Thermometer, Data Loggers, Non contact Thermometers, Infrared Thermometers etc. (1)
10. Calculation of refrigeration and freezing loads for various products and storage rooms (1)
11. Calculation of time required for precooling commodities (1)
12. Calculations of costs and benefits associated with a change in selected postharvest practices (1)
13. Artificial ripening of fruits and vegetables in ripening chambers with the use of ethylene gas (1)
14. Sorting and grading of fruits and vegetables by automatic grading machine (1)
15. Modified atmosphere packaging of fruits and vegetables (2)
16. Vacuum packaging of fruits and vegetables (1/2)
17. Shrink packaging of fruits and vegetables (1/2)
18. Extending shelf life of flowers with the use of holding solutions (1/2)
19. Project preparation for establishing processing units (1)
20. Identification of machinery used in small, medium and large scale processing units (2)
21. Preparation of fruit jam, its economics and marketing

22. Preparation of fruit jelly, its economics and marketing
23. Preparation of squash, its economics and marketing
24. Preparation of chutney, its economics and marketing
25. Preparation of tomato puree, its economics and marketing
26. Preparation of tomato ketchup, its economics and marketing
27. Preparation of whole tomato crush, its economics and marketing
28. Preparation of candied fruits, its economics and marketing
29. Preparation of preserve, its economics and marketing
30. Preparation of dried and dehydrated products, its economics and marketing
31. Canning of vegetables
32. Preparation of marmalade, its economics and marketing
33. Preparation of pickles, its economics and marketing
34. Food safety and regulatory aspects
35. New food laws according to Quality Council of India 2009
36. Practical aspects of GAP
37. Practical aspects of Good Manufacturing Practices
38. Procedure for HACCP
39. Government schemes related to postharvest and processing of Horticultural crops

M.Sc.

HORT 511 TROPICAL AND DRY LAND FRUIT PRODUCTION 2+1

Objective

To impart basic knowledge about the importance and management of tropical and dry land fruits grown in India.

Theory

Commercial varieties of regional, national and international importance, ecophysiological requirements, recent trends in propagation, rootstock influence, planting systems, cropping systems, root zone and canopy management, nutrient management, water management, fertigation, role of

bioregulators, abiotic factors limiting fruit production, physiology of flowering, pollination fruit set and development, honeybees in cross pollination, physiological disorders- causes and remedies, quality improvement by management practices; maturity indices, harvesting, grading, packing, storage and ripening techniques; industrial and export potential, Agri. Export Zones(AEZ) and industrial supports.

Crops

UNIT I: Mango and Banana

UNIT II: Citrus and Papaya

UNIT III: Guava, Sapota and Jackfruit

UNIT IV: Pineapple, Annonas and Avocado

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

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical and arid zone orchards, Project preparation for establishing commercial orchards.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits - Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. 2001. (Eds.). *Fruits -Tropical and Subtropical*. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vols. IIIV. Malhotra Publ. House.

Nakasone HY & Paul RE. 1998. *Tropical Fruits*. CABI.

Peter KV. 2008. (Ed.). *Basics of Horticulture*. New India Publ. Agency.

Pradeep kumar T, Suma B, Jyothibhaskar & Satheesan KN. 2008. *Management of Horticultural Crops*. Parts I, II. New India Publ. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Singh HP, Negi JP & Samuel JC. (Eds.). 2002. *Approaches for Sustainable Development of Horticulture*. National Horticultural Board.

Singh HP, Singh G, Samuel JC & Pathak RK. (Eds.). 2003. *Precision Farming in Horticulture*. NCPAH, DAC/PFDC, CISH, Lucknow.

HORT 512 SUBTROPICAL AND TEMPERATE FRUIT PRODUCTION 2+1

Objective

To impart basic knowledge about the importance and management of subtropical and temperate fruits grown in India.

Theory

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

Crops

UNIT I: Apple, pear, quince, grapes

UNIT II: Plums, peach, apricot, cherries, hazlenut

UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry

UNIT IV: Nuts- walnut, almond, pistachio, pecan

UNIT V: Minor fruits- mangosteen, carambola, bael, wood apple, fig, jamun, rambutan, pomegranate

Practical

Identification of important cultivars, observations on growth and development, practices in growth regulation, malady diagnosis, analyses of quality attributes, visit to tropical, subtropical, humid tropical and temperate orchards, Project preparation for establishing commercialorchards.

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Ed.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.
Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

HORT 513 PRODUCTION TECHNOLOGY OF WARM SEASON VEGETABLE CROPS **2+1**

Objective

To teach production technology of warm season vegetables.

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, economics of crop production 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

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Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya

Prokash.
Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.
Bose TK, Som MG & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.
Brown HD & Hutchison CS. *Vegetable Science*. JB Lippincott Co.
Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture*. Vols. V-X. Malhotra Publ. House.
Chadha KL. (Ed.). 2002. *Hand Book of Horticulture*. ICAR.
Chauhan DVS. (Ed.). 1986. *Vegetable Production in India*. Ram Prasad & Sons.
Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
Edmond JB, Musser AM & Andrews FS. 1964. *Fundamentals of Horticulture*. Blakiston Co
Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.
Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
Kalloo G & Singh K (Ed.). 2000. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.
Nayer NM & More TA 1998. *Cucurbits*. Oxford & IBH Publ.
Palaniswamy & Peter KV. 2007. *Tuber Crops*. New India Publ. Agency.
Pandey AK & Mudranalay V. (Eds.). *Vegetable Production in India: Important Varieties and Development Techniques.*
Rana MK. 2008. *Olericulture in India*. Kalyani.
Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani.
Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.
Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co. 33

Singh NP, Bharadwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distributing Co.
Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
Thamburaj S & Singh N. 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

HORT 514 PROPAGATION AND NURSERY MANAGEMENT 2+1 FOR FRUIT CROPS

Objective

Familiarization with principles and practices of propagation and nursery management for fruit crops.

Theory

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

Nursery – types, structures, components, planning and layout. Nursery

management practices for healthy propagule production.

Practical

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

Suggested Readings

Hartmann HT & Kester DE. 1989. *Plant Propagation – Principles and Practices*. Prentice Hall of India.

Bose TK, Mitra SK & Sadhu MK. 1991. *Propagation of Tropical and Subtropical Horticultural Crops*. Naya Prokash.

Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.

Singh SP. 1989 *Mist Propagation*. Metropolitan Book Co.

Rajan S & Baby LM. 2007. *Propagation of Horticultural Crops*. New IndiaPubl. Agency.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

HORT 515 BREEDING OF FRUIT CROPS 2+1

Objective

To impart comprehensive knowledge about the principles and practices of breeding of fruit crops.

Theory

Origin and distribution, taxonomical status - species and cultivars, cytogenetics, genetic resources, blossom biology, breeding systems, breeding objectives, ideotypes, approaches for crop improvement - introduction, selection, hybridization, mutation breeding, polyploid breeding, rootstock breeding, improvement of quality traits, resistance breeding for biotic and abiotic stresses, biotechnological interventions, achievements and future thrust in the following selected fruit crops.

Crops

UNIT I : Mango, banana and pineapple

UNIT II: Citrus, grapes, guava and sapota

UNIT III: Jackfruit, papaya, custard apple, aonla, avocado and ber

UNIT IV: Mangosteen, litchi, jamun, phalsa, mulberry, raspberry, kokam and nuts

UNIT V**:** Apple, pear, plums, peach, apricot, cherries and strawberry

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, ploidy breeding, mutation breeding, evaluation of biometrical traits and quality traits, screening for resistance, developing breeding programme for specific traits, visit to research stations working on tropical, subtropical and temperate fruit improvement

Suggested Readings

Bose TK, Mitra SK & Sanyol D. (Eds.). 2002. *Fruits of India – Tropical and Sub-tropical*. 3rd Ed. Vols. I, II. Naya Udyog.

Chadha KL & Pareek OP. 1996. (Eds.). *Advances in Horticulture*. Vol. I. Malhotra Publ. House.

Chadha KL & Shikhamany SD. 1999. *The Grape: Improvement, Production and Post-Harvest Management*. Malhotra Publ. House.

Janick J & Moore JN. 1996. *Fruit Breeding*. Vols.I-III. John Wiley & Sons.

Nijjar GS. 1977. (Eds.). *Fruit Breeding in India*. Oxford & IBH.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency. 16

Singh S, Shivankar VJ, Srivastava AK & Singh IP. (Eds.). 2004. *Advances in Citriculture*. Jagmander Book Agency.

HORT 516 BIOTECHNOLOGY OF HORTICULTURAL CROPS 2+1

Objective

Understanding the principles, theoretical aspects and developing skills in biotechnology of horticultural crops.

Theory

UNIT I

Harnessing bio-technology in horticultural crops, influence of plant materials, physical, chemical factors and growth regulators on growth and development of plant cell, tissue and organ culture.

UNIT II

Callus culture – types, cell division, differentiation, morphogenesis, organogenesis, embryogenesis.

UNIT III

Use of bioreactors and *in vitro* methods for production of secondary metabolites, suspension culture, nutrition of tissues and cells, regeneration of tissues, ex vitro, establishment of tissue cultured plants.

UNIT IV

Physiology of hardening - hardening and field transfer, organ culture – meristem, embryo, anther, ovule culture, embryo rescue, somaclonal variation, protoplast culture and fusion.

UNIT V

Construction and identification of somatic hybrids and cybrids, wide hybridization, *in vitro* pollination and fertilization, haploids, *in vitro* mutation, artificial seeds, cryopreservation, rapid clonal propagation, genetic engineering in horticulture crops, use of molecular markers. *In vitro* selection for biotic and abiotic stress, achievements of biotechnology in horticultural crops.

Practical

An exposure to low cost, commercial and homestead tissue culture laboratories, media preparation, inoculation of explants for clonal propagation, callus induction and culture, regeneration of plantlets from callus, sub-culturing, techniques on anther, ovule, embryo culture, somaclonal variation, *in vitro* mutant selection against abiotic stress, protoplast culture, fusion technique, development of protocols for mass multiplication, project development for establishment of commercial tissue culture laboratory.

Suggested Readings

Bajaj YPS. (Ed.).1989. *Biotechnology in Agriculture and Forestry*. Vol. V, *Fruits*. Springer.

Brown TA. 2001. *Gene Cloning and DNA Analysis and Introduction.* Blackwell Publ.19

Chopra VL & Nasim A. 1990. *Genetic Engineering and Biotechnology – Concepts, Methods and Applications.* Oxford & IBH.

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Vasil TK, Vasi M, While DNR & Bery HR.1979. *Somatic Hybridization and Genetic Manipulation in Plants. Plant Regulation and World Agriculture*. Planum Press.
Williamson R. 1981-86. *Genetic Engineering*. Vols. I-V. Academic Press.

HORT 521 BIODIVERSITY AND CONSERVATION OF FRUIT CROPS 2+1

Objective

Understanding the principles of biodiversity and strategies in germplasm conservation of fruit crops.

Theory

UNIT I

Biodiversity and conservation; issues and goals, centers of origin of cultivated fruits; primary and secondary centers of genetic diversity.

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UNIT II

Present status of gene centers; exploration and collection of germplasm; conservation of genetic resources – conservation *in situ* and *ex situ.*

UNIT III

Germplasm conservation- problem of recalcitrancy - cold storage of scions, tissue culture, cryopreservation, pollen and seed storage; inventory of germplasm, introduction of germplasm, plant quarantine.

UNIT IV

Intellectual property rights, regulatory horticulture. Detection of genetic constitution of germplasm and maintenance of core group.

UNIT V

GIS and documentation of local biodiversity, Geographical indication.

Crops

Mango, sapota, citrus, guava, banana, papaya, grapes, jackfruit, custard, apple, ber, aonla, malus*, Prunus* sp, litchi, nuts, coffee, tea, rubber, cashew, coconut, cocoa, palmyrah, arecanut, oil palm and betelvine.

Practical

Documentation of germplasm – maintenance of passport data and other records of accessions; field exploration trips, exercise on *ex situ* conservation – cold storage, pollen/seed storage, cryopreservation, visits to National Gene Bank and other centers of PGR activities. Detection of genetic constitution of germplasm, core sampling, germplasm characterization using molecular techniques.

Suggested Readings

Frankel OH & Hawkes JG. 1975. *Crop Genetic Resources for Today and Tomorrow*. Cambridge University Press.

Peter KV & Abraham Z. 2007. *Biodiversity in Horticultural Crops*. Vol. I.

Daya Publ. House.
Peter KV. 2008. *Biodiversity of Horticultural Crops*. Vol. II. Daya Publ. House.

HORT 522 PRODUCTION TECHNOLOGY OF COOL SEASON 2+1 VEGETABLE CROPS

Objective

To educate production technology of cool season vegetables.

Theory

Introduction, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production of:

UNIT I

Potato

UNIT II

Cole crops: cabbage, cauliflower, knoll kohl, sprouting broccoli, Brussels sprout

UNIT III

Root crops: carrot, radish, turnip and beetroot

UNIT IV

Bulb crops: onion and garlic

UNIT V

Peas and broad bean, green leafy cool season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of winter vegetable crops and their economics; Experiments to demonstrate the role of mineral elements, plant growth substances and herbicides; study of physiological disorders; preparation of cropping scheme for commercial farms; visit to commercial greenhouse/ polyhouse.

Suggested Readings

Bose TK & Som MG. (Eds.). 1986. *Vegetable Crops in India*. Naya Prokash.

Bose TK, Som G & Kabir J. (Eds.). 2002. *Vegetable Crops*. Naya Prokash.

Bose TK, Som MG & Kabir J. (Eds.). 1993. *Vegetable Crops*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Chadha KL & Kalloo G. (Eds.). 1993-94. *Advances in Horticulture* Vols.

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Decoteau DR. 2000. *Vegetable Crops*. Prentice Hall.
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Fageria MS, Choudhary BR & Dhaka RS. 2000. *Vegetable Crops: Production Technology*. Vol. II. Kalyani.
Gopalakrishanan TR. 2007. *Vegetable Crops*. New India Publ. Agency.
Hazra P & Som MG. (Eds.). 1999. *Technology for Vegetable Production and Improvement*. Naya Prokash.
Rana MK. 2008. *Olericulture in India*. Kalyani Publ.
Rana MK. 2008. *Scientific Cultivation of Vegetables*. Kalyani Publ.
Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables: Principles, Production and Nutritive Values*. Chapman & Hall.
Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.
Salunkhe DK & Kadam SS. (Ed.). 1998. *Hand Book of Vegetable Science and Technology: Production, Composition, Storage and Processing*. Marcel Dekker.
Shanmugavelu KG. 1989. *Production Technology of Vegetable Crops*. Oxford & IBH.
Singh DK. 2007. *Modern Vegetable Varieties and Production Technology*. International Book Distributing Co.
Singh SP. (Ed.). 1989. *Production Technology of Vegetable Crops*. Agril. Comm. Res. Centre.
Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops and Spices*. ICAR.
Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata McGraw-Hill.

HORT 523 PRODUCTION TECHNOLOGY OF CUT FLOWERS 2+1

Objective

To impart basic knowledge about the importance and production technology of cut flowers grown in India.

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

Growing environment, open cultivation, protected cultivation, soil requirements, artificial growing media, soil decontamination techniques, planting methods, influence of environmental parameters, light, temperature, moisture, humidity and CO2 on growth and flowering.

UNIT III

Flower production – water and nutrient management, fertigation, weed management, rationing, training and pruning, disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and IDM, production for exhibition purposes.

UNIT IV

Flower forcing and year round flowering through physiological interventions, chemical regulation, environmental manipulation.

UNIT V

Cut flower standards and grades, harvest indices, harvesting techniques, post-harvest handling, Methods of delaying flower opening, Pre-cooling, pulsing, packing, Storage & transportation, marketing, export potential, institutional support, Agri Export Zones.

Crops: Cut rose, cut chrysanthemum, carnation, gerbera, gladioli, tuberose, orchids, anthurium, aster, liliums, bird of paradise, heliconia, alstroemeria, alpinia, ornamental ginger, bromeliads, dahlia, gypsophilla, limonium, statice, stock, 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.

Suggested Readings

Arora JS. 2006. *Introductory Ornamental horticulture*. Kalyani.
Bhattacharjee SK. 2006. *Advances in Ornamental Horticulture*. Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. *Commercial Flowers.* Naya Prokash.
Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture andLandscaping.* Naya Prokash.
Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.
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Lauria A & Ries VH. 2001. *Floriculture – Fundamentals and Practices.* Agrobios.
Prasad S & Kumar U. 2003. *Commercial Floriculture.* Agrobios.
Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.
Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. *Hightech Floriculture.* Indian Society of Ornamental Horticulture, New Delhi.

HORT 531 LANDSCAPING AND ORNAMENTAL GARDENING 2+1

Objective

Familiarization with principles and practices of landscaping and ornamental gardening.

Theory

UNIT I

Landscape designs, types of gardens, English, Mughal, Japanese, Persian, Spanish, Italian, Vanams, Buddha garden; Styles of garden, formal, informal and free style gardens.

UNIT II

Urban landscaping, Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, damsites, IT parks, corporates.

UNIT III

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

UNIT IV

Lawns, Establishment and maintenance, special types of gardens, vertical

garden, roof garden, bog garden, sunken garden, rock garden, clock garden, colour wheels, temple garden, sacred groves.

UNIT V

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

Practical

Selection of ornamental plants**,** practices in preparing designs for home gardens, industrial gardens, institutional gardens, corporates, avenue planting, practices in planning and planting of special types of gardens, burlapping, lawn making, planting herbaceous and shrubbery borders, project preparation on landscaping for different situations, visit to parks and botanical gardens, case study on commercial landscape gardens.

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Suggested Readings

Bose TK, Maiti RG, Dhua RS & Das P. 1999. *Floriculture and Landscaping.* Naya Prokash.

Lauria A & Victor HR. 2001. *Floriculture – Fundamentals and Practices* Agrobios.

Nambisan KMP.1992. *Design Elements of Landscape Gardening*. Oxford & IBH.

Randhawa GS & Mukhopadhyay A. 1986. *Floriculture in India*. Allied Publ.

Sabina GT & Peter KV. 2008. *Ornamental Plants for Gardens*. New India Publ. Agency.

Valsalakumari et al. 2008. *Flowering Trees*. New India Publ. Agency.

Woodrow MG.1999. *Gardening in India.* Biotech Books.

HORT 532 POST HARVEST TECHNOLOGY FOR HORTICULTURALCROPS 2+1

Objective

To facilitate deeper understanding on principles and practices of postharvest management of horticulturalcrops.

Theory

UNIT I

Maturity indices, harvesting practices for specific market requirements, influence of

pre-harvest practices, enzymatic and textural changes,

respiration, transpiration.

UNIT II

Physiology and biochemistry of fruit ripening, ethylene evolution and ethylene management, factors leading to post-harvest loss, pre-cooling.

UNIT III

Treatments prior to shipment, viz., chlorination, waxing, chemicals, biocontrol agents and natural plant products. Methods of storage eventilated, refrigerated, MAS, CA storage, physical injuries and disorders.

UNIT IV

Packing methods and transport, principles and methods of preservation, food processing, canning, fruit juices, beverages, pickles, jam, jellies, candies.

UNIT V

Dried and dehydrated products, nutritionally enriched products, fermented fruit beverages, packaging technology, processing waste management, 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 oftranspiration, respiration rate, ethylene release and study of vase lifeextension 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 vegetableprocessing units, project preparation, evaluation of processed horticultural products.

Suggested Readings

Bhutani RC. 2003. *Fruit and Vegetable Preservation*. Biotech Books.

Chadha KL & Pareek OP. (Eds.). 1996 *Advances in Horticulture*. Vol. IV.Malhotra Publ. House.

Haid NF & Salunkhe SK. 1997. *Post Harvest Physiology and Handling of Fruits and Vegetables*. Grenada Publ.

Mitra SK. 1997. *Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits*. CABI.

Ranganna S. 1997. *Hand Book of Analysis and Quality Control for Fruit and Vegetable Products*. Tata McGraw-Hill.

Sudheer KP & Indira V. 2007. *Post Harvest Technology of Horticultural Crops*. New India Publ. Agency.

Willis R, Mc Glassen WB, Graham D & Joyce D. 1998. *Post Harvest. An*17 *Introduction to the Physiology and Handling of Fruits, Vegetables and Ornamentals*. CABI.

HORT 533 PRODUCTION TECHNOLOGY OF SPICE CROPS 2+1

Objective

To impart basic knowledge about the importance and production technology of spices grown in India.

Theory

Introduction, importance of spice crops-historical accent, present status - national and international, future prospects, botany and taxonomy, climatic and soil requirements, commercial varieties/hybrids, site selection, layout, sowing/planting times and methods, seed rate and seed treatment, nutritional and irrigation requirements, intercropping, mixed cropping, intercultural operations, weed control, mulching, physiological disorders,

harvesting, post harvest management, plant protection measures and seed planting material and micro-propagation, precision farming, organic resource management, organic certification, quality control, pharmaceutical significance and protected cultivation of:

UNIT I

Black pepper, cardamom

UNIT II

Clove, cinnamon and nutmeg, allspice

UNIT III

Turmeric, ginger and garlic

UNIT IV

Coriander, fenugreek, cumin, fennel, ajowain, dill, celery

UNIT V

Tamarind, garcinia and vanilla

Practical

Identification of seeds and plants, botanical description of plant; preparation of herbarium, propagation, nursery raising, field layout and method of planting, cultural practices, harvesting, drying, storage, packaging and processing, value addition; short term xperiments on spice crops.

Suggested Readings

Agarwal S, Sastry EVD & Sharma RK. 2001. *Seed Spices: Production,Quality, Export*. Pointer Publ.

Arya PS. 2003. *Spice Crops of India*. Kalyani.

Bhattacharjee SK. 2000. *Hand Book of Aromatic Plants*. Pointer Publ.

Bose TK, Mitra SK, Farooqi SK & Sadhu MK (Eds.). 1999. *Tropical Horticulture*. Vol.I. Naya Prokash.

Chadha KL & Rethinam P. (Eds.). 1993. *Advances in Horticulture*. Vols. IX-X. *Plantation Crops and Spices*. Malhotra Publ. House.

Gupta S. (Ed.). *Hand Book of Spices and Packaging with Formulae*. Engineers India Research Institute, New Delhi.

Kumar NA, Khader P, Rangaswami & Irulappan I. 2000. *Introduction to Spices, Plantation Crops, Medicinal and Aromatic Plants*. Oxford & IBH.

Nybe EV, Miniraj N & Peter KV. 2007. *Spices*. New India Publ. Agency.

Parthasarthy VA, Kandiannan V & Srinivasan V. 2008. *Organic Spices*. New India Publ. Agency.

Peter KV. 2001. *Hand Book of Herbs and Spices*. Vols. I-III. Woodhead Publ. Co. UK and CRC USA 68

Pruthi JS. (Ed.). 1998. *Spices and Condiments*. National Book Trust

Pruthi JS. 2001. *Minor Spices and Condiments- Crop Management and Post Harvest Technology*. ICAR.

Purseglove JW, Brown EG, Green CL & Robbins SRJ. (Eds.). 1981. *Spices*. Vols. I, II. Longman.

Shanmugavelu KG, Kumar N & Peter KV. 2002. *Production Technology of Spices and Plantation Crops*. Agrobios.

Thamburaj S & Singh N. (Eds.). 2004. *Vegetables, Tuber Crops andSpices*. ICAR.

Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*.International Book Distr. Co.

Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

HORT 611 ADVANCES IN PRODUCTION OF FRUIT CROPS 2+1

Objective

To keep abreast with latest developments and trends in production technology of fruit crops.

Theory

National and International scenario in fruit production, Recent advances in propagation - root stock influence, planting systems, High density planting,

crop modeling , 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) - Current topics.

Crops

UNIT I : Mango and banana

UNIT II: Papaya, grapes and citrus

UNIT III: Guava, sapota, pomegranate and aonla

UNIT IV: Pineapple, avocado, jack fruit and fig

UNIT V**:** Apple, pear, plums, strawberry, peach, apricot, cherries and nut crops

Practical

Survey of existing fruit cropping systems and development of a model cropping system, Estimating nutrient deficiency- estimation of water use efficiency, soil test-crop response correlations, practices in plant growth regulation, studying physiological and biochemical responses, quality analysis.

Suggested Readings

Bose TK, Mitra SK & Rathore DS. (Eds.). 1988. *Temperate Fruits – Horticulture*. Allied Publ.

Bose TK, Mitra SK & Sanyal D. (Eds.). 2001. *Fruits -Tropical and* 24 *Subtropical*. Naya Udyog.

Bose TK, Mitra SK, Farooqi AA & Sadhu MK. 1999. *Tropical Horticulture.* Vol. I. Naya Prokash.

Chadha KL & Pareek OP. (Eds.).1996. *Advances in Horticulture*. Vols. IIIV. Malhotra Publishing House.

Chadha KL. 2001. *Handbook of Horticulture*. ICAR.

Nakasone HY & Paull RE. 1998. *Tropical Fruits*. CABI.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

HORT 612 BIOTIC AND ABIOTIC STRESS MANAGEMENT IN HORTICULTURAL CROPS 2+1

Objective

To update knowledge on the recent research trends in the field of biotic and abiotic stress management in horticultural crops.

Theory

UNIT I

Stress – definition, classification, stresses due to water (high and low), temperature (high and low), radiation, wind, soil conditions (salinity, alkalinity, ion toxicity, fertilizer toxicity, etc.).

UNIT II

Pollution - increased level of CO2, industrial wastes, impact of stress in horticultural crop production, stress indices, physiological and biochemical factors associated with stress, horticultural crops suitable for different stress situations.

UNIT III

Crop modeling for stress situations, cropping system, assessing the stress through remote sensing, understanding adaptive features of crops for survival under stress, interaction among different stress and their impact on crop growth and productivity.

UNIT IV

Greenhouse effect and methane emission and its relevance to abiotic stresses, use of anti transpirants and PGRs in stress management, mode of action and practical use, HSP inducers in stress management techniques of soil moisture conservation, mulching, hydrophilic polymers.

UNIT V

Rain water harvesting, increasing water use efficiency, skimming technology, contingency planning to mitigate different stress situations, cropping systems, stability and sustainability indices.

Practical

Seed treatment /hardening practices, container seedling production, analysis of soil moisture estimates (FC, ASM, PWP), analysis of plant stress factors, 27 RWC, chlorophyll flurosence, chlorophyll stability index, ABA content, plant waxes, stomatal diffusive resistance, transpiration, photosynthetic rate etc. under varied stress situations, influence of stress on growth and development of seedlings and roots, biological efficiencies, WUE, solar energy conversion and efficiency, crop growth sustainability indices, economics of stress management, visit to orchards and water shed locations.

Suggested Readings

Blumm A. 1988. *Plant Breeding for Stress Environments*. CRC.

Christiansen MN & Lewis CF. 1982. *Breeding Plants for Less Favourable Environments.* Wiley Inter. Science.

Gupta US. 1990. *Physiological Aspects of Dry Farming*.

Hsiao TC. 1973. Plant Responses to Water Stress. *Ann. Rev. PlantPhysiology* 24: 519-570.
Kramer PJ. 1980. Drought Stress and the Origin of Adaptation. In:
Adaptation of Plants to Water and High Temperature Stress. John Wiley & Sons.
Levitt J. 1972. *Response of Plants to Environmental Stresses*. Academic Press.
Maloo SR. 2003. *Abiotic Stress and Crop Productivity*. Agrotech Publ. Academy.
Mussell H & Staples R. 1979. *Stress Physiology in Crop Plants*. Wiley Inter. Science.
Nickell LG. 1983. *Plant Growth Regulating Chemicals*. CRC.
Peter KV. (Ed.). 2008. *Basics of Horticulture*. New India Publ. Agency.
Turener NC & Kramer PJ. 1980. *Adaptation of Plants to Water and High Temperature Stress*. John Wiley & Sons. 28

HORT 621 ADVANCES IN VEGETABLE PRODUCTION 2+1

Objective

To keep abreast with latest developments and trends in production technology of vegetable crops.

Theory

Present status and prospects of vegetable cultivation; nutritional and medicinal values; 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 manures, inorganic fertilizers, micronutrients and biofertilizers; response of genotypes to low and high nutrient management, nutritional deficiencies, disorders and correction methods; different cropping systems; mulching; containerized culture for year round vegetable production; low cost polyhouse; net house production; crop modeling, organic gardening; vegetable production for pigments, export and processing of:

UNIT I

Tomato, brinjal, chilli, sweet pepper and potato

UNIT II

Cucurbits, cabbage, cauliflower and knol-khol

UNIT III

Bhendi, onion, peas and beans, amaranthus and drumstick

UNIT IV

Carrot, beet root and radish

UNIT V

Sweet potato, tapioca, elephant foot yam and taro

Practical

Seed hardening treatments; practices in indeterminate and determinate vegetable growing and organic gardening; portrays and ball culture; 41 diagnosis of nutritional and physiological disorders; analysis of physiological factors like anatomy; photosynthesis; light intensity in different cropping situation; assessing nutrient status, use of plant growth

regulators; practices in herbicide application; estimating water requirements in relation to crop growth stages, maturity indices; dryland techniques for rainfed vegetable production; production constraints; analysis of different cropping system in various situation like cold and hot set; vegetable waste recycling management; quality analysis ;marketing survey of the above crops; visit to vegetable and fruit mals and packing houses.

Suggested Readings

Bose TK & Som NG. 1986. *Vegetable Crops of India*. Naya Prokash.

Bose TK, Kabir J, Maity TK, Parthasarathy VA & Som MG. 2003. *Vegetable Crops*. Vols. I-III. Naya Udyog.

Brewster JL. 1994. *Onions and other Vegetable Alliums*. CABI.

FFTC. *Improved Vegetable Production in Asia*. Book Series No. 36.

Ghosh SP, Ramanujam T, Jos JS, Moorthy SN & Nair RG. 1988. *Tuber Crops*. Oxford & IBH.

Gopalakrishnan TR. 2007. *Vegetable Crops*. New India Publishing Agency.

Kallo G & Singh K. (Ed.). 2001. *Emerging Scenario in Vegetable Research and Development*. Research Periodicals & Book Publ. House.

Kurup GT, Palanisami MS, Potty VP, Padmaja G, Kabeerathuma S & Pallai SV. 1996. *Tropical Tuber Crops, Problems, Prospects and Future Strategies*. Oxford & IBH.

Sin MT & Onwueme IC. 1978. *The Tropical Tuber Crops*. John Wiley & Sons.

Singh NP, Bhardwaj AK, Kumar A & Singh KM. 2004. *Modern Technology on Vegetable Production*. International Book Distr. Co.

Singh PK, Dasgupta SK & Tripathi SK. 2006. *Hybrid Vegetable Development*. International Book Distr. Co.

HORT 623 ADVANCES IN GROWTH REGULATION OF FRUIT CROPS 2+1

Objective

Appraisal on the advances in growth regulation of fruit crops.

Theory

UNIT I

Ecophysiological influences on growth and development of fruit crops flowering, fruit set- Crop load and assimilate partitioning and distribution.

UNIT II

Root and canopy regulation, study of plant growth regulators in fruit culture- structure, biosynthesis, metabolic and morphogenetic effects of different plant growth promoters and growth retardants.

UNIT III

Absorption, translocation and degradation of phytohormones – internal and external factors influencing hormonal synthesis, biochemical action, growth promotion and inhibition, canopy management for fertigated orchards.

UNIT IV

Growth regulation aspects of propagation, embryogenesis, seed and bud dormancy, fruit bud initiation, regulation of flowering, off season production.

UNIT V

Flower drop and thinning, fruitset and development, fruit drop, parthenocarpy, fruit maturity and ripening and storage, molecular approaches in crop growth regulation- current topics.

Practical

Root- shoot studies, quantifying the physiological and biochemical effects of physical and chemical growth regulation, bioassay and isolation through chromatographic analysis for auxins, gibberellins, experiments on growth regulation during propagation, dormancy, flowering, fruitset and fruit development stages.

Suggested Readings

Buchanan B, Gruiessam W & Jones R. 2002. *Biochemistry & Molecular Biology of Plants*. John Wiley & Sons.

Epstein E. 1972. *Mineral Nutrition of Plants: Principles and Perspectives*. Wiley.

Fosket DE. 1994. *Plant Growth and Development: A Molecular Approach*. Academic Press.

Leoplod AC & Kriedermann PE. 1985. *Plant Growth and Development*. 3rd Ed. McGraw-Hill.

Radha T & Mathew L. 2007. *Fruit Crops*. New India Publ. Agency.

Roberts J, Downs S & Parker P. 2002. Plant Growth Development. In: *Plants* (I. Ridge, Ed.), pp. 221-274, Oxford University Press.

Salisbury FB & Ross CW. 1992. *Plant Physiology*. 4th Ed. Wadsworth Publ.

HORT 624 PROTECTED CULTIVATION OF VEGETABLE CROPS 1+1

Objective

To impart latest knowledge in growing of vegetable crops under protected environmental condition.

Theory

Crops: Tomato, capsicum, cucumber, melons and lettuce

UNIT I

Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT II

Regulatory structures used in protected structures; types of greenhouse/polyhouse/nethouse, hot beds, cold frames, effect of environmental factors, *viz.* temperature, light, CO2 and humidity on growth of different vegetables, manipulation of CO2, light and temperature for vegetable production, fertigation.

UNIT III

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

UNIT IV

Regulation of flowering and fruiting in vegetable crops, technology for raising tomato, sweet pepper, cucumber and other vegetables in protected structures, training and staking in protected crops, varieties and hybrids for growing vegetables in protected structures.

UNIT V

Problem of growing vegetables in protected structures and their remedies, insect and disease management in protected structures; soil-less culture, use of protected structures for seed production.

Practical

Study of various types of structures, methods to control temperature, CO2 light, media, training and pruning, maintenance of parental lines and hybrid seed production of vegetables, fertigation and nutrient management, control of insect-pests and disease in greenhouse; economics of protected cultivation, visit to established green/polyhouse/net house/shade house in

the region.

Suggested Readings

Anonymous 2003. *Proc. All India Seminar on Potential and Prospects for Protective Cultivation*. Organised by Institute of Engineers, Ahmednagar. Dec.12-13, 2003.

Chandra S & SomV. 2000. *Cultivating Vegetables in Green House*. *Indian Horticulture* 45: 17-18.

Prasad S & Kumar U. 2005. *Greenhouse Management for Horticultural Crops*. 2nd Ed. Agrobios.

Tiwari GN. 2003. *Green House Technology for Controlled Environment*.Narosa Publ. House.

DEPARTMENT OF MOLECULAR BIOLOGY AND BIOTECHNOLOGY

PROGRAMMES:

1. B.Sc.(Ag)
1. M.Sc.(Ag)
2. Ph.D.

COURSE REQUIREMENTS:

B.Sc.(Ag)

Field of Specialization	Agriculture
Undergradute Course	MBB - 31 I,MBB - 321

M.Sc.

Field of Specialization	Tissue Culture, Molecular Markers, Industrial Biotechnology and Genetic Engineering
Core Courses	MBB 511, MBB 512 MBB 513 and MBB 523
Optional Courses	MBB 521, MBB 522, MBB 524, MBB 525,MBB 526, MBB 531, MBB 532, MBB 533, MBB 534, MBB 535, MBB 536, MBB 541, MBB 591
Minor & Supporting Courses	STAT511, PPHY521, PPHY512, PBG 512 or as per decision of advisory committee in view of research problem.
Non Credit Compulsory Courses	PGS 502,PGS 503
Deficiency Courses	AGRON111, AGRON211, AGRON311, AGRON312, SCHEM 111, HORT 211,PBG211 or as deemed suitable

	by advisory committee

Ph.D.

Field of Specialization	Tissue Culture, Molecular Markers, Industrial Biotechnology and Genetic Engineering
Core Courses	MBB 611 and MBB 612
Optional Courses	MBB 621, MBB 622, MBB 623, MBB 624, MBB 641, MBB 691, MBB 692
Minor & Supporting Courses	STAT613**,** PPHY621, HORT 625, PBG 622 or as per decision of advisory committee in view of research problem.
Non Credit Compulsory Courses	PGS 502, PGS 503(Exempted if done in M.Sc.)
Deficiency Courses	AGRON111, AGRON211, AGRON311, AGRON312,SCHEM 111, HORT 211, PBG211, HORT 312 or as deemed suitable by advisory committee

Course Structure – At a Glance

S.No.	**CODE**	**COURSE TITLE**	**CREDITS**	**SEMESTER/YEAR**	**REMARKS**
B.Sc.(Ag)					
1.	MBB311	Introductory Biochemistry	2+1	IIIrd Year	Compulsory
2.	MBB321	Principles of Plant Biotechnology	2+1	IIIrd Year	Compulsory
M.Sc. Courses					
1.	MBB 511*	PRINCIPLES OF BIOTECHNOLOGY	2+1	I	Core
2.	MBB 512*	FUNDAMENTALS OF MOLECULAR BIOLOGY	3+0	I	Core
3.	MBB 513	MOLECULAR CELL BIOLOGY	3+0	II	Optional
4.	MBB 521	GENERAL BIOCHEMISTRY	2+1	I	Compulsory
5.	MBB	PLANT TISSUE	2+1	II	Optional

	522	CULTURE & GENETIC TRANSFORMATION			
6.	MBB 523*	TECHNIQUES IN MOLECULAR BIOLOGY	1+2	II	Core
7.	MBB 524	GENOMICS & PROTEOMICS	3+0	II	Optional
8.	MBB 525	IMMUNOLOGY AND MOLECULAR DIAGNOSTICS	2+1	II	Optional
9.	MBB 526/ PBG511	PRINCIPLES OF GENETICS	2+1	II	Optional
10.	MBB 531	NANO-BIOTECHNOLOGY	3+0	III	Optional
11.	MBB 532	INTRODUCTION TO BIOINFORMATICS	2+1	III	Optional
12.	MBB 533	ENVIRONMENTAL BIOTECHNOLOGY	3+0	III	Optional
13.	MBB 534	PRINCIPLES OF MICROBIOLOGY	2+1	III	Optional
14.	MBB 535	INDUSTRIAL BIOTECHNOLOGY	2+1	III	Optional
15.	MBB 536	BIOSAFETY, IPR AND BIOETHICS	3+0	III	Optional
16.	MBB 541	COMPREHENSIVE	Non-credit	-	-
17.	MBB 591	MASTER'S SEMINAR	1+0	III	Compulsory
18.	MBB 599	MASTER'S RESEARCH	20	IV	Compulsory
Ph.D. Courses					
1	MBB 611*	ADVANCES IN PLANT MOLECULAR BIOLOGY	3+0	I	Core
2	MBB 612*	ADVANCES IN CROP BIOTECHNOLOGY	3+0	I	Core
3	MBB 621	ADVANCES IN GENETIC	3+0	II	Optional

		ENGINEERING			
4	MBB 622	ADVANCES IN MICROBIAL BIOTECHNOLOGY	2+1	II	Optional
5	MBB 623	COMMERCIAL PLANT TISSUE CULTURE	2+1	II	Optional
6	MBB 624	ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS	3+0	II	Optional
7	MBB 641	COMPREHENSIVE	Non-credit	-	-
8	MBB 691	DOCTORAL SEMINAR I	1+0	III	Compulsory
9	MBB 692	DOCTORAL SEMINAR II	1+0	IV	Compulsory
8	MBB 699	DOCTORAL RESEARCH	45		Compulsory

DESCRIPTION OF COURSES

Undergraduate Courses:

III YEAR:

MBB 311 INTRODUCTORY BIOCHEMISTRY 3(2+1)

Objective

To provide elementary knowledge/overview of structure, functions and metabolism of biomolecules.

Theory: Biochemistry – Introduction and importance, Plant cell, cell wall and its role in live stock, food; and paper; industries, Bio-molecules-Structure, properties and applications: Amino acids, peptides and proteins-Plant proteins and their quality. Enzymes- factors affecting the activity, classification, Immobilization and other industrial applications. Lipids-Acyl lipids, Their industrial application in soaps, detergents, paints, Varnishes, lubricants, adhesives, plastics, nylon, Bio-diesel, Biodegradable plastics etc. Carbohydrates; Nucleotides and Nucleic acids, Metabolic energy and its generation. Metabolism-Basic concepts, Glycolysis, Citric acid Cycle, Pentose phosphate pathway, oxidative phosphorylation, Fatty acid oxidation. General reactions of amino acid degradation. Biosynthesis-carbohydrates, Lipids, Proteins and Nucleic acids. Metabolic regulation. Secondary

metabolites, Terpenoids, Alkaloids, Phenolics and their applications in food and pharmaceutical industries.

Practical: Paper Chromatography 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 TLC; Extraction of oil from oil seeds; Estimation of fatty acids by GLC; Quantitative determination of sugars; Isolation characterization of nucleic acids determination of terpenoids and alkaloids.

Text/Reference books

1) Reginald H. Garnett and Charles M.Grisham (2005). Biochemstry. Thomson Brooks/Cole USA.

2) Mousumi Debnath (2005). Tools and Techniques of Biotechnology. Pointer Publishers Jaipur

3) Lehninger (2004). Principles of Biochemistry. W.H. Freeman and Company.USA

4) Goodwin and Mercer (2003) Introduction to Plant Biochemistry. CBS Publishers & Distributors, New Delh

5) Sahney, S.K. and Singh, R.R. (2002) Introductory Practical; Biochemistry. Narosa Publishing House.New Delhi.

6) Rodney Boyer. (2001). Modern Experimental Biochemistry. Pearson Education, Inc. Singapore

7) Buchanan, B.B; Gruissem. Wilhelm and Jones Russell L.(2000)Biochemistry and Molecular Biology of Plants. J.K International Pvt. Ltd.

MBB 321 : PRINCIPLES OF PLANT BIOTECHNOLOGY

3(2+1)

Objective

To provide elementary knowledge/overview of plant biotechnology principles and concepts.

Theory: Concepts of Plant Biotechnology: History of Plant Tissue Culture and Plant Genetic Engineering; Scope and importance in Crop Improvement. Totipotency and Morphogenesis, Nutritional requirements of *in-vitro* cultures; Techniques of *in-vitro* cultures, Micro propagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors

affecting above *in-vitro* culture; Applications and Achievements; Somaclonal variation, Types, Reasons: Somatic embryogenesis ;and synthetic seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications of tissue culture in crop improvements; Plant Genetic engineering; Restriction enzymes; Vectors for gene transfer- Gene cloning-Direct and indirect method of gene transfer-Transgenic plants and their; application. DNA finger printing- DNA based markers- RFLP, AFLP, RAPD, SSR and DNA Probes-Mapping QTL-Future prospects. MAS, and its application in crop improvement. Molecular analysis of transgenics

Practical: 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 synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Isolation of DNA, Purity analysis, Restriction analysis of Plant DNA, gene transfer techniques, direct methods, indirect methods; Demonstration of Confirmation genetic transformants.

Recommended books:

Bains W (2004) Biotechnology: From A to Z 3rd Edn Oxford University press Oxford

Purohit S S (2004) Biotechnoology: Fundamentals and Applications 3rd Edn. Student Edition, Jodhpur

Gupta P K (2004) Biotechnology and genomics, Rastogi publications, Meerut

Chawla H S (2002) Introduction to Plant Biotechnology. 2nd Edn Oxford IBH publishing New Delhi

Ratledge C and Kristiansen B (2001) Basic Biotechnology 2nd Edn. Cambridge Univ Press

Postgraduate Courses:

MBB 511 PRINCIPLES OF BIOTECHNOLOGY (2+1)*

Objective

To familiarize the students with the fundamental principles of Biotechnology, various developments in Biotechnology and its potential applications.

Theory

UNIT I- History, scope and importance; DNA structure and function.

UNIT II - DNA modifying enzymes and vectors; Methods of recombinant DNA technology; Nucleic acid hybridization; Gene libraries; PCR amplification;Plant and animal cell, tissue culture techniques and their applications.

UNIT III - Molecular markers and their applications; DNA sequencing; Applications of gene cloning in basic and applied research; Genetic engineering and transgenics; Genomics, transcriptomics and proteomics.

UNIT IV - General application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics;Public perception of biotechnology; Bio-safety and bioethics issues; Intellectual property rights in biotechnology.

Practical

i.Isolation of genomic and plasmid DNA

ii.Gel electrophoresis techniques

iii.Restriction enzyme digestion, ligation, theoretical demonstration of transformation and screening of transformants

iv.PCR and molecular marker analysis

v.Plant tissue culture: media preparation, cell and explant culture, regeneration and transformation.

Suggested Readings

Becker JM, Coldwell GA & Zachgo EA. 2007. Biotechnology -a Laboratory Course. Academic Press.

Brown CM, Campbell I & Priest FG. 2005. Introduction to Biotechnology. Panima Pub.

Brown TA. Gene Cloning and DNA Analysis. 5th Ed. Blackwell Publishing.

Dale JW & von Schantz M. 2002. From Genes to Genomes: Concepts and Applications of DNA Technology. John Wiley & Sons.

Gupta PK. 2004. Biotechnology and Genomics. Rastogi Publications.

Sambrook J, Fritsch T & Maniatis T. 2001. Molecular Cloning – a Laboratory Manual. 2nd Ed. Cold Spring Harbour Laboratory Press.

Singh BD. 2007. Biotechnology Expanding Horiozon. Kalyani Publishers.

MBB 512 FUNDAMENTALS OF MOLECULAR BIOLOGY (3+0)*

Objective

To familiarize the students with the basic cellular processes at molecular level.

Theory

UNIT I

Historical developments of molecular biology; Nucleic acids as genetic material; Chemistry, structure and properties of DNA and RNA.

UNIT II

Genome organization in prokaryotes and eukaryotes; Chromatin structure and function; DNA replication; DNA polymerases, topoisomerases, DNA ligase, etc; Molecular basis of mutations; DNA repair mechanisms.

UNIT III

Transcription process; RNA processing; Reverse transcriptase; RNA editing; Ribosomes structure and function; Organization of ribosomal proteins and RNA genes; Genetic code; Aminoacyl tRNA synthases.

UNIT IV

Translation and post-translational modifications; Operon concept; Attenuation of trp operon; important features of gene regulation in eukaryotes.

Suggested Readings

Lewin B. 2008. Gene IX. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. Essentials of Molecular Biology. 3rd Ed. Jones & Bartlett Publishers.

Nelson DL & Cox MM. 2007. Lehninger's Principles of Biochemistry. W.H. Freeman & Co.

Primrose SB. 2001. Molecular Biotechnology. Panima.

Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6th Ed. Pearson Education International.

MBB 513 MOLECULAR CELL BIOLOGY(3+0)*

Objective

To familiarize the students with the cell biology at molecular level.

Theory

UNIT I

General structure and constituents of cell; Similarities and distinction between plant and animal cells; Cell wall, cell membrane, structure and composition of biomembranes, cell surface related functions.

UNIT II

Structure and function of major organelles: Nucleus, Chloroplasts, Mitochondria, Ribosomes, Lysosomes, Peroxisomes, Endoplasmic reticulum, Microbodies, Golgi apparatus, Vacuoles, etc.

UNIT III

Organellar genomes and their manipulation; Ribosomes in relation to cell growth and division; Cyto-skeletal elements.

UNIT IV

Cell division and regulation of cell cycle; Membrane transport; Transport of water, ion and biomolecules; Signal transduction mechanisms; Protein targeting.

Suggested Readings

Gupta PK. 2003. Cell and Molecular Biology. 2nd Ed. Rastogi Publ.

Lodish H. 2003. Molecular Cell Biology. 5th Ed. W.H. Freeman & Co.

Primrose SB. 2001. Molecular Biotechnology. Panima.

MBB 521 GENERAL BIOCHEMISTRY (2+1) Compulsory

Objective

To provide elementary knowledge/overview of structure, functions and metabolism of biomolecules.

Theory

UNIT I

Scope and importance of biochemistry in agriculture; Fundamental principles governing life; structure of water; acid base concept and buffers; pH; hydrogen bonding; hydrophobic, electrostatic and Van der Waals forces; General introduction to physical techniques for determination of structure of biopolymers.

UNIT II

Classification, structure and function of carbohydrates, lipids and biomembranes, amino acids, proteins, and nucleic acids.

UNIT III

Structure and biological functions of vitamins, enzymes classification and mechanism of action; regulation, factors affecting enzyme action. Fundamentals of thermodynamic principles applicable to biological processes, Bioenergetics.

UNIT IV

Metabolism of carbohydrates, photosynthesis and respiration, oxidative phosphorylation, lipids, proteins and nucleic acids. DNA replication, transcription and translation; recombinant DNA technology, Nutritional aspects of carbohydrates, lipids, proteins and minerals.

Practical

i. Preparation of standard and buffer solutions.
ii. Extraction and estimation of sugars and amino acids.
iii Estimation of proteins by Lowry's method.
iv. Estimation of DNA and RNA by Diphenylamine and orcinol methods.
v. Estimation of ascorbic acid.
vi. Separation of biomolecules by TLC and paper chromatography
vii. Demonstration of GLC and HPLC.

Suggested Readings

Conn EE & Stumpf PK. 1987. Outlines of Biochemistry. John Wiley.
Metzler DE. Biochemistry. Vols. I, II. Wiley International.
Nelson DL & Cox MM. 2004. Lehninger's Principles of Biochemistry. MacMillan.
Seth P and Khandelwal SK.2008. Biochemical Analysis. Himanshu Publications.
Voet D & Voet JG. Biochemistry. 3rd Ed. Wiley International.

MBB 522 PLANT TISSUE CULTURE AND GENETIC TRANSFORMATION (2+1)

Objective

To familiarize the students and provide hands on training on various techniques of plant tissue culture, genetic engineering and transformation.

Theory

UNIT I

History of plant cell and tissue culture; Culture media; Various types of culture; callus, suspension, nurse, root, meristem, etc.; In vitro differentiation: organogenesis and somatic embryogenesis; Plant growth regulators: mode of action, effects on in vitro culture and regeneration; Molecular basis of plant organ differentiation.

UNIT II

Micropropagation; Anther and microspore culture; Somaclonal variation; In vitro mutagenesis; In vitro fertilization; In vitro germplasm conservation; Production of secondary metabolites; Synthetic seeds.

UNIT III

Embryo rescue and wide hybridization; Protoplast culture and regeneration; Somatic hybridization: protoplast fusion, cybrids, asymmetric hybrids, etc.

UNIT IV

Methods of plant transformation; Vectors for plant transformation; Genetic and molecular analyses of transgenics; Target traits and transgenic crops; Biosafety issues, testing of transgenics, regulatory procedures for commercial approval.

Practical

i. Laboratory set-up.

ii. Preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.

iii.Anther and pollen culture.

iv. Embryo rescue.

v. Suspension cultures and production of selected secondary metabolites.

vi.Gene transfer using different methods, reporter gene expression, selection of transformed tissues/plants, molecular analysis.

Suggested Readings

Bhojwani SS. 1983. Plant Tissue Culture: Theory and Practice. Elsevier.

Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley& Sons.

Dixon RA. 2003. Plant Cell Culture. IRL Press.
George EF, Hall MA & De Klerk GJ. 2008. Plant Propagation by Tissue Culture. Agritech Publ.
Gupta PK. 2004. Biotechnology and Genomics. Rastogi Publ.
Herman EB. 2005-08. Media and Techniques for Growth, Regeneration and Storage. Agritech Publ.
Pena L. 2004. Transgenic Plants: Methods and Protocols. Humana Press.
Pierik RLM. 1997. In vitro Culture of Higher Plants. Kluwer.
Singh BD. 2007. Biotechnology: Expanding Horiozon. Kalyani.

MBB 523 TECHNIQUES IN MOLECULAR BIOLOGY (1+2)

Objective

To provide hands on training on basic molecular biology techniques.

Theory

UNIT I

Purification of proteins by different methods, theory of extraction procedures, centrifugation principles, salting- out salting –in, dialysis, gel filtration, ion-exchange chromatography, electrophoresis, molecular weight determination, western-blotting

UNIT II- Introduction to molecular markers such as RAPD, RFLP, SSR. Dot blot analysis; Southern hybridization; Northern hybridization; Western blotting

Practical

UNIT I

Good lab practices; Biochemical techniques: Preparation of buffers and reagents.Gel electrophoresis- agarose and PAGE (nucleic acids and proteins);

UNIT II

Growth of bacterial culture and preparation of growth curve; Isolation of plasmid DNA from bacteria; Restriction digestion of plasmid DNA; Isolation plant DNA and its purity analysis.

UNIT III

Gene cloning – genetic transformation and selection of transformants; PCR and optimization of factors affecting PCR and RAPD analysis

Suggested Readings

Ausubel FM, Brent R, Kingston RE, Moore DD, Seidman JG, Smith JA & Struhl K. 2002. Short Protocols in Molecular Biology. John Wiley.
Kun LY. 2006. Microbial Biotechnology. World Scientific.

Sambrook J, Russel DW & Maniatis T. 2001. Molecular Cloning: a Laboratory Manual. Cold Spring Harbour Laboratory Press.

MBB 524 GENOMICS AND PROTEOMICS (3+0)

Objective

To familiarize the students with recent tools used for genome analysis and their applications.

Theory

UNIT I

Structural genomics: Classical ways of genome analysis, large fragment genomic libraries; Physical mapping of genomes; Genome sequencing, sequence assembly and annotation; Comparative genomics, etc.

UNIT II

Functional genomics: DNA chips and their use in transcriptome analysis; Mutants and RNAi in functional genomics; Metabolomics and ionomics for elucidating metabolic pathways, etc.

UNIT III

Proteomics -Protein structure, function and purification; Introduction to basic proteomics technology; Bio-informatics in proteomics; Proteome analysis, etc.

UNIT IV

General uses and application of Crystallograpgy. enzymes engineering, design and construction of novel enzymes

UNIT V

Applications of genomics and proteomics in agriculture, human health and industry.

Suggested Readings

Azuaje F & Dopazo J. 2005. Data Analysis and Visualization in Genomics and Proteomics. John Wiley & Sons.

Brown TA. 2007. Genome III. Garland Science Publ.

Campbell AM & Heyer L. 2004. Discovery Genomics, Proteomics and Bioinformatics. Pearson Education.

Gibson G & Muse SV. 2004. A Primer of Genome Science. Sinauer Associates.

Jollès P & Jörnvall H. 2000. Proteomics in Functional Genomics: Protein Structure Analysis. Birkhäuser.

Kamp RM. 2004. Methods in Proteome and Protein Analysis. Springer.
Primrose SB & Twyman RM. 2007. Principles of Genome Analysis and Genomics. Blackwell.
Sensen CW. 2005. Handbook of Genome Research. Vols. I, II. Wiley CVH.

MBB 525 IMMUNOLOGY AND MOLECULAR DIAGNOSTICS (2+1)

Objective

To discuss the application of various immunological and molecular diagnostic tools.

Theory

UNIT I

History and scope of immunology; Components of immune system: organs, tissues and cells, Immunoglobulin chemistry, structure and functions;Molecular organization of immunoglobulins and classes of antibodies.

UNIT II

Antibody diversity; antigens, haptens, antigens- antibody interactions; immuno-regulation and tolerance; Allergies and hypersensitive response; Immunodeficiency; Vaccines; Immunological techniques.

UNIT III

Immunological application in plant science, monoclonal antibodies and their uses, molecular diagnostics. Introduction to the basic principles of molecular technology and techniques used in pathogen detection, Principles of ELISA and its applications in viral detection.

UNIT IV

Basics and procedures of PCR, Real time PCR, PCR based and hybridization based methods of detection, microarrays based detection, multiplexing etc, detection of soil borne and seed born infections, transgene detection in seed, planting material and processed food, molecular detection of varietal impurities and seed admixtures in commercial consignments.

Practical

i. Preparation of buffers and reagents.
ii. Immunoblotting, immunoelectrophoresis and fluorescent antibody test.
iii. Enzyme immunoassays including ELISA western blotting.
iv. Extraction and identification of DNA/RNA of pathogenic organisms.

Suggested Readings

Bloom BR & Lambert P-H. 2002. The Vaccine Book. Academic Press.

Elles R & Mountford R. 2004. Molecular Diagnosis of Genetic Disease. Humana Press.
Kindt TJ, Goldsby RA & Osbrne BA. 2007. Kuby's Immunology. WH Freeman.
Levine MM, Kaper JB, Rappuoli R, Liu MA & Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare.
Lowrie DB & Whalen R. 2000. DNA Vaccines. Humana Press.
Male D, Brostoff J, Roth DB & Roitt I. 2006. Immunology. Elsevier.
Rao JR, Fleming CC & Moore JE. 2006. Molecular Diagnostics. Horizon Bioscience.
Robinson A & Cranage MP. 2003. Vaccine Protocols. 2nd Ed. Humana Press.
Spinger TA, 1985. Hybridoma Technology in Biosciences and Medicine.Plenum Press.

BB 526 PRINCIPLES OF GENETICS (2+1)

Objective

This course is aimed at understanding the basic concepts of genetics, helping students to develop their analytical, quantitative and problem-solving skills from classical to molecular genetics.

Theory

UNIT I

Early concepts of inheritance; Discussion on Mendel's paper; Sex determination, differentiation and sex-linkage, Sex-influenced and sex-limited traits; Linkage, recombination and genetic mapping in eukaryotes, Somatic cell genetics.

UNIT II

Structural and numerical changes in chromosomes; Nature, structure and replication of the genetic material; Organization of DNA in chromosomes; Mutations and mutagenic agents.

UNIT III

Genetic code and protein biosynthesis; Gene regulation, Genes in development; Extra chromosomal inheritance, Male sterility and incompatibility; Recombination in bacteria, fungi and viruses, tetrad analysis.

UNIT IV

Inheritance of quantitative traits; Concepts in population genetics; Genes and behavior; Genetics and evolution; Recombinant DNA technology; Genetic fine structure analysis, Split genes, Transposable genetic elements, Overlapping genes,

Pseudogenes, Oncogenes, Gene families; An overview of some recent discoveries in the field of genetics.

Practical

i. Laboratory exercises in probability and chi-square.
ii. Demonstration of genetic principles using laboratory organisms.
iii. Chromosome mapping using three point test cross.
iv. Tetrad analysis.
v. Induction and detection of mutations through genetic tests.
vi. Pedigree analysis in humans.
vii. Numerical problems on Hardy Weinberg Equilibrium, Quantitative inheritance and Molecular genetics.

Suggested Readings

Klug WS & Cummings MR. 2003 Concepts of Genetics. Peterson Education.
Lewin B. 2008. Genes IX. Jones & Bartlett Publ.
Russell PJ. 1998. Genetics. The Benzamin/Cummings Publ. Co.
Strickberger MW.1990. Genetics. Collier MacMillan.
Tamarin RH. 1999. Principles of Genetics. Wm. C. Brown Publs.
Uppal S, Yadav R, Subhadra & Saharan RP. 2005. Practical Manual on Basic and Applied Genetics. Dept. of Genetics, CCS HAU Hisar.

MBB 531 NANO-BIOTECHNOLOGY (3+0)

Objective

Understanding the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.

Theory

UNIT I

Introduction to Biomacromolecules: The modern concepts to describe the conformation and dynamics of biological macromolecules: scattering techniques, micromanipulation techniques, drug delivery applications etc.

UNIT II

Cellular engineering: signal transduction in biological systems, feedback control signaling pathways, cell-cell interactions etc. Effects of physical, chemical and electrical stimuli on cell function and gene regulation.

UNIT III

Chemical, physical and biological properties of biomaterials and bioresponse: biomineralization, biosynthesis, and properties of natural materials (proteins,

DNA, and polysaccharides), structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological Systems,

UNIT IV

Preparation and characterization of nanoparticles; Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano-imaging, Metabolic engineering and Gene therapy.

Suggested Readings

Nalwa HS. 2005. Handbook of Nanostructured Biomaterials and Their Applications in Nanobiotechnology. American Scientific Publ.

Niemeyer CM & Mirkin CA. 2005. Nanobiotechnology. Wiley Interscience.

MBB 532 INTRODUCTION TO BIOINFORMATICS (2+1)

Objective

To impart an introductory knowledge about the subject of bioinformatics to the students studying any discipline of science.

Theory

UNIT I

Introduction, biological databases – primary, secondary and structural, Protein and Gene Information Resources – PIR, SWISSPROT, PDB, genebank, DDBJ. Specialized genomic resources.

UNIT II

DNA sequence analysis, cDNA libraries and EST, EST analysis, pairwise alignment techniques, database searching, multiple sequence alignment.

UNIT III

Secondary database searching, building search protocol, computer aided drug design – basic principles, docking, QSAR.

UNIT IV

Analysis packages – commercial databases and packages, GPL software for Bioinformatics, web-based analysis tools.

Practical

i. Usage of NCBI resources

ii. Retrival of sequence/structure from databases

iii. Visualization of structures

iv. Docking of ligand receptors

v. BLAST exercises.

Suggested Readings

Attwood TK & Parry-Smith DJ. 2003. Introduction to Bioinformatics. Pearson Education.

Rastogi SC, Mendiratta N & Rastogi P. 2004. Bioinformatics: Concepts, Skills and Applications. CBS.

MBB 533 ENVIRONMENTAL BIOTECHNOLOGY (3+0)

Objective

To apprise the students about the role of biotechnology in environment management for sustainable eco-system and human welfare.

Theory

UNIT I

Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control; waste water treatment - physical, chemical and biological processes; need for water and natural resource management.

UNIT II

Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides & toxic chemicals, detergents etc; aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc); anaerobic processes: digestion, filteration, etc.

UNIT III

Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact; biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture, etc.

UNIT IV

Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by micro-organisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management of environmental problems.

Suggested Readings

Evans GM & Furlong JC. 2002. Environmental Biotechnology: Theory and Application. Wiley International.
Jordening H-J & Winter J. 2006. Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag.

MBB 534 PRINCIPLES OF MICROBIOLOGY (2+1)

Objective

To acquaint the students with history, classification and role of microbiology in agriculture, food and environment.

Theory

UNIT I

Development of Microbiology in the 18th and 19th century. Morphology, structure and function of prokaryotic and eukaryotic cell. Archea. Classification of prokaryotes – Basic principles and techniques used in bacterial classification.

UNIT II

Evolutionary relationship among prokaryotes. Phylogenetic and numerical taxonomy. Use of DNA and r-RNA sequencing in classifications.

UNIT III

Study of major groups of bacteria belonging to Gracilicutes, Firmicutes, Tanericutes and Mendosicutes.

UNIT IV

Viruses – morphology, classification and replication of plant, animal and bacterial viruses. Cultivation methods of viruses. Immune response – specific and non-specific resistance. Normal microflora of human body; some common bacterial and viral diseases of humans/plants and animals.

Practical

i. Methods of isolation, purification and maintenance of microorganisms from different environments (air, water, soil, milk and food).

ii. Enrichment culture technique – isolation of asymbiotic, symbiotic nitrogen fixing bacteria. Isolation of photosynthetic bacteria.

iii. Use of selective media, antibiotic resistance and isolation of antibiotic producing microorganisms.

iv. Morphological, physiological and biochemical characterization of bacteria.

Suggested Readings

Brock TD. 1961. Milestones in Microbiology. Infinity Books.
Pelczar ML Jr. 1997. Microbiology. Tata McGraw Hill.

Stainier RY, Ingraham JL, Wheelis ML & Painter PR. 2003. General Microbiology. MacMillan.
Tauro P, Kapoor KK & Yadav KS. 1996. Introduction to Microbiology. Wiley Eastern.

MBB 535 INDUSTRIAL BIOTECHNOLOGY (2+1)

Objective

To familiarize about the various microbial processes/systems/activities, which have been used for the development of industrially important products/processes.

Theory

UNIT I

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms.

UNIT II

Primary metabolism products, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non ribosomal peptide antibiotics; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic pathway engineering of microbes for production of novel product for industry.

UNIT III

Microbial enzymes and their role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bioaugmentation with production of vitamin C as a case study; Bioreactors, their design and types; Immobilized enzymes based bioreactors; Microencapsulation technologies for immobilization of microbial enzymes.

UNIT IV

Industrial biotechnology for pollution control, treatment of industrial and other wastes, biomass production involving single cell protein; Bioremediation of soil; Production of eco-friendly agricultural chemicals, biopesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

Practical

i. Isolation of industrially important microorganisms, their maintenance and improvement.

ii. Production of industrial compounds such as alcohol/citric acid/ lactic acid and their recovery.
iii. Study of bio-reactors and their operations.
iv. Production of biofertilizers.
v. Experiments on microbial fermentation process, harvesting purification and recovery of end products.

Suggested Readings

Huffnagle GB & Wernick S. 2007. The Probiotics Revolution: The Definitive Guide to Safe, Natural Health. Bantam Books.
Kun LY. 2006. Microbial Biotechnology. World Scientific.
Primrose SB. 2001. Molecular Biotechnology. Panima.

MBB 536 BIOSAFETY, IPR AND BIOETHICS (3+0)

Objective

To discuss about various aspects of biosafety regulations, IPR and bioethic concerns arising from the commercialization of biotech products.

Theory

UNIT I

Biosafety and risk assessment issues; Regulatory framework; National biosafety policies and law, The Cartagena protocol on biosafety, WTO and other international agreements related to biosafety, Cross border movement of germplasm; Risk management issues - containment.

UNIT II

General principles for the laboratory and environmental biosafety; Health aspects; toxicology, allergenicity, antibiotic resistance, etc; Impact on environment: gene flow in natural and artificial ecologies; Sources of gene escape, tolerance of target organisms, creation of superweeds/superviruses, etc.

UNIT III

Ecological aspects of GMOs and impact on biodiversity; Monitoring strategies and methods for detecting transgenics; Radiation safety and non-radio isotopic procedure; Benefits of transgenics to human health, society and the environment.

UNIT IV

The WTO and other international agreements; Intellectual properties, copyrights, trademarks, trade secrets, patents, geographical indications, etc; Protection of plant variety and farmers right act; Indian patent act and amendments, patent filing; Convention on biological diversity; Implications of intellectual property rights on the commercialization of biotechnology products.

Suggested Readings

Singh BD. 2007. Biotechnology: Expanding Horizon. Kalyani.
http://patentoffice.nic.in
www.wipo.org
www.dbtindia.nic.in
www.dbtbiosafety.nic.in

Ph.D. Courses:

MBB 611 ADVANCES IN PLANT MOLECULAR BIOLOGY (3+0)*

Objective

To discuss the specialized topics and recent advances in the field of plant molecular biology.

Theory

UNIT I

Arabidopsis in molecular biology, Forward and Reverse Genetic Approaches, Transcriptional and post-transcriptional regulation of gene expression, isolation of promoters and other regulatory elements.

UNIT II

RNA interference, Transcriptional gene silencing, Transcript and protein analysis, use of transcript profiling to study biological systems.

UNIT III

Hormone regulatory pathways: Ethylene, Cytokinin, Auxin and ABA, SA and JA; ABC Model of Floral Development, Molecular basis of self incompatibility, Regulation of flowering: photoperiod, vernalization, circadian rhythms.

UNIT IV

Molecular biology of abiotic stress responses: Cold, high temperature, submergence, salinity and drought; Molecular Biology of plant-pathogen interactions, molecular biology of Agrobacterium Infection, Molecular biology of Rhizobium infection (molecular mechanisms in symbiosis), Programmed cell death in development and defense.

Suggested Readings

Buchanan B, Gruissen W & Jones R. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, USA.
Lewin B. 2008. Gene IX. Peterson Publications/ Panima.

Malacinski GM & Freifelder D. 1998. Essentials of Molecular Biology. 3rdEd. Jones & Bartlett Publ.
Nelson DL & Cox MM. 2007. Lehninger's Principles of Biochemistry. WH Freeman & Co.
Watson JD, Bakee TA, Bell SP, Gann A, Levine M & Losick R. 2008. Molecular Biology of the Gene. 6th Ed. Pearson Education.

MBB 612 ADVANCES IN CROP BIOTECHNOLOGY (3+0)*

Objective

To discuss specialized topics on the application of molecular tools in breeding of specific crops.

Theory

UNIT I

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on available molecular marker, transformation and genomic tools for crop improvement.

UNIT II

Genetic engineering for resistance against abiotic (drought, salinity, flooding, temperature, etc) and biotic (insect pests, fungal, viral and bacterial diseases, weeds, etc) stresses; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc); edible vaccines, etc.

UNIT III

Molecular breeding: constructing molecular maps; integrating genetic, physical and molecular maps; diversity assessment and phylogenetic analysis; molecular tagging of genes/traits; selected examples on marker-assisted selection of qualitative and quantitative traits.

UNIT IV

Discussion on application of molecular, transformation and genomic tools for the genetic enhancement in some major field crops such as rice, wheat, cotton, maize, soybean, oilseeds, sugarcane etc.

Suggested Readings

Specific journals and published references.

BB 621 ADVANCES IN GENETIC ENGINEERING (3+0)

Objective

To discuss the specialized topics and advances in field of genetic engineering and their application in plant improvement.

Theory

UNIT I

General overview of transgenic plants; Case studies: Genetic engineering of herbicide resistance, Transgenic plants resistant to insects/pests, Genetic engineering of abiotic stress tolerance, Engineering food crops for quality, Genetically engineered pollination control, Induction of male sterility in plants.

UNIT II

Molecular farming of plants for applications in veterinary and human medicine systems: Boosting heterologous protein production in transgenics, Rapid production of specific vaccines, High-yield production of therapeutic proteins in chloroplasts.

UNIT III

Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement; Gene stacking; Pathway engineering; Marker-free transgenic development strategies; High throughput phenotyping of transgenic plants.

UNIT IV

Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

UNIT V

Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarray profiling

Suggested Readings

Christou P & Klee H. 2004. Handbook of Plant Biotechnology. John Wiley & Sons.

MBB 622 ADVANCES IN MICROBIAL BIOTECHNOLOGY (2+1)

Objective

To discuss specialized topics about industrially important microorganisms.

Theory

UNIT I

Fermentative metabolism and development of bioprocessing technology, processing and production of recombinant products; isolation, preservation and improvement of industrially important microorganisms.

UNIT II

Immobilization of enzymes and cells; Batch, plug flow and chemostate cultures; Computer simulations; Fed-batch and mixed cultures; Scale-up principles; Down stream processing etc.

UNIT III

Current advances in production of antibiotics, vaccines, and biocides; Steroid transformation; Bioreactors; Bioprocess engineering; Production of non-microbial origin products by genetically engineered microorganisms.

UNIT IV

Concept of probiotics and applications of new tools of biotechnology for quality feed/food production; Microorganisms and proteins used in probiotics; Lactic acid bacteria as live vaccines; Factors affecting delignification; Bioconversion of substrates, anti-nutritional factors present in feeds; Microbial detoxification of aflatoxins; Single cell protein, Bioinsecticides; Biofertilizers; Recent advances in microbial biotechnology.

Practical

i. Enrichment culture and isolation of agriculturally important microorganisms
ii. Isolation of antibiotic producing microorganisms
iii. Isolation of industrially important microorganisms, their maintenance and improvement.
iv. Production of industrial compounds such as industrial alcohol/ citric acid/lactic acid and their recovery.
v. Study of bio-reactors and their operations.
vi. Demonstration of bioinsecticides / biofertlizers production.

MBB 623 COMMERCIAL PLANT TISSUE CULTURE (2+1)

Objective

To discuss the commercial applications of plant tissue culture in agriculture, medicine and industry.

Theory

UNIT I

Micropropagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

UNIT II

Production of useful compounds via biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

UNIT III

Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethic issues; management and commercialization.

UNIT IV

Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

Practical

i. Laboratory set-up, preparation of nutrient media; handling and sterilization of plant material; inoculation, subculturing and plant regeneration.
ii. Case studies of commercial plant regeneration system of important aromatic/ medicinal plants

Suggested Readings

Specific journals and published references.

MBB 624 **ADVANCES IN FUNCTIONAL GENOMICS AND PROTEOMICS (3+0)**

Objective

To discuss recent advances and applications of functional genomics and proteomics in agriculture, medicine and industry.

Theory

UNIT I

Genome sequencing and functional genomics; Human, animal, plant, bacterial and yeast genome projects; genome annotation; ab initio gene discovery; functional annotation and gene family clusters; etc.

UNIT II

Functional analysis of genes; RNA-mediated interference; gene knockoffs; Gene traps/ T-DNA insertion lines; homologous recombination; microarrayprofiling; SAGE; SNPs/variation; yeast-two hybrid screening; gene expression and transcript profiling; EST contigs; EcoTILLING; allele/gene mining; synteny and comparative genomics; Genome evolution, speciation and domestication etc.

UNIT II

Proteomics: protein annotation; protein separation and 2D PAGE; mass spectroscopy; protein microarrays; protein interactive maps; structural proteomics: protein structure determination, prediction and threading, software and data analysis/ management, etc.

UNIT IV

Discussion on selected papers on functional genomics, proteomics, integrative genomics etc.

Suggested Readings

Specific journals and published references.

DEPARTMENT OF NEMATOLOGY

RAJASTHAN COLLEGE OF AGRICULTURE, UDAIPUR

PROGRAMMES:

1. M.Sc.

2. Ph.D.

COURSE REQUIREMENTS:

M.Sc.(Ag)

Field of specialization	**Nematode taxonomy, Nematode management, Nematode biodiversity and EPNs**
Core courses	**NEMAT 511, NEMAT 512, NEMAT 513, NEMAT 521**
Optional courses	**NEMAT 514,NEMAT 522, NEMAT 523, NEMAT 524, NEMAT 531, NEMAT 532, NEMAT 533, NEMAT 534, NEMAT 535 & NEMAT 536**
Minor & supporting courses	**STAT511,PPATH513 or as per the decision of advisory committee in view of research problem**
Non Credit compulsory courses	**PGS502 & PGS503**
Deficiency courses	**Nil or as deemed suitable by advisory committee**

Ph.D(Nematology)

Field of specialization	**Nematode taxonomy, Nematode management, Nematode biodiversity and EPNs**

Core courses	**NEMAT 611 & NEMAT 612**
Optional courses	**NEMAT 621, NEMAT 622, NEMAT 623 & NEMAT 624**
Minor & supporting courses	**STAT612, PPATH513 & PPATH523 or as per the decision of advisory committee in view of research problem**
Non Credit compulsory courses	**PGS502 & PGS503 (Exempted if done in M.Sc.)**
Deficiency courses	**Nil or as deemed suitable by advisory committee**

B.Sc. (Ag.) Pt.III, Semester IInd

NEMAT 321 Elementary Nematology (B. Sc. Ag) 2 (1+1)

Theory

History and economic importance of nematodes; characters of phylum Nematoda, systematic position of nematodes in animal kingdom; general morphology and biology of nematodes; plant nematode relationship; nematode ecology and disease complexes. Nematode diseases of crop plants of economic importance with special reference to Meloidogyne, Heterodera, Pratylenchus, Radopholus, Anguina, Rotylenchulus and Tylenchulus. Principles of nematode management, integrated pest management.

Practical

Collection of soil and plant samples, extraction of nematodes from soil and roots. Preparation of temporary mounts of nematodes, staining and separation of nematodes in plant tissues, collection and preservation of diseased plant samples, identification of important plant parasitic nematodes.

Suggested Reading:

1. R.K.Walia and H.K.Bajaj (2003). Text book on Introductory Plant Nematology. ICAR New Delhi publication.
2. Reddy,P.P. (1993). A treatise on phytonematology. Agric. Publ.Academy, New Delhi.
3. Sasser, J.N. and W.R.Jenkins. Nematology. S.Chand & Company, Ramnagar, New Delhi.
4. Singh,R.S. & K.Sitaramaiah (1993). Plant Pathoges the Nematodes. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi
5. Swarup,G. (1982). Padap Krimivigyan, Rajasthan Sahitya Academy, Jaipur (in Hindi)

DEPARTMENT OF NEMATOLOGY
(COURSES TO BE OFFERED)
M.Sc. (Ag.) Ist SEMESTER

S.NO.	COURSE NO.	TITLE OF COURSE	CREDIT
1.	NEMAT.511	PRINCIPLES OF NEMATOLOGY ©	2+1
2.	NEMAT.512	NEMATOLOGICAL TECHNIQUE ©	1+2
3.	NEMAT.513	STRUCTURAL AND FUNCTIONAL ORGANIZATION OF NEMATODES ©	2+1

M.Sc.(Ag.) II nd SEMESTER

S.NO.	COURSE NO.	TITLE OF COURSE	CREDIT
1.	NEMAT.521	CLASSIFICATION OF NEMATODES	2+1
2.	NEMAT.522	NEMATODE DISEASES OF CROPS ©	2+1
3.	NEMAT.523	NEMATODE ECOLOGY	2+1

M.Sc.(Ag.) III rd SEMESTER

S.NO.	COURSE NO.	TITLE OF COURSE	CREDIT
1.	NEMAT.531	NEMATODE BIOLOGY AND PHYSIOLOGY	2+1
2.	NEMAT.532	NEMATODE INTERACTIONS WITH OTHER ORGANISMS	2+1
3.	NEMAT.533	NEMATODE MANAGEMENT	2+1
4.	NEMAT.534	BENEFICIAL NEMATODES	2+1
5.	NEMAT.591	SEMINAR	1+0
6.	NEMAT541	COMPREHENSIVE	NC
7.	NEMAT.599	MASTERS RESEARCH	20

Ph.D. Ist SEMESTER

S.NO.	COURSE NO.	TITLE OF COURSE	CREDIT
1.	NEMAT.611	ADVANCES IN STRUCTURAL & SYSTEMATICS OF NEMATODES ©	2+1
2.	NEMAT.612	ADVANCES NEMATODE MANAGEMENT ©	2+1
3.	NEMAT.691	SEMINAR-I	1+0

Ph.D. IInd SEMESTER

S.NO.	COURSE NO.	TITLE OF COURSE	CREDIT
1.	NEMAT.621	CURRENT TOPICS IN NEMATODE DISEASE DEVELOPMENT AND HOST RESISTANCE	2+1
2.	NEMAT.622	ADVANCED NEMATODE TECHNIQUES	2+1
3.	NEMAT.623	ADVANCES IN BIOLOGICAL CONTROL OF NEMATODES	2+1
4.	NEMAT.624	ADVANCE NEMATODE ECOLOGY	2+1
5.	NEMAT.692	SEMINAR-II	1+0
6.	NEMAT641	PRILIMINARY	NC
7.	NEMAT699	DOCTORAL RESEARCH	45

Course Contents

M.Sc.(Ag.)

NEMAT 511 PRINCIPLES OF NEMATOLOGY © 2+1

Objective

To project the importance of nematodes in agriculture and impart basic knowledge on all aspects of plant Nematology.

Theory

UNIT I

History and growth of Nematology; nematode habitats and diversity-plant, animal and human parasites; useful nematodes; economic importance of nematodes to agriculture, horticulture and forestry.

UNIT II

Gross morphology of plant parasitic nematodes; broad classification, nematode biology, physiology and ecology.

UNIT III

Types of parasitism; nature of damage and general symptomatology; interaction of plant parasitic nematodes with other organisms.

UNIT IV

Plant nematode relationships, cellular responses to infection by important phytonematodes; physiological specialization among phytonematodes.

UNIT V

Principles and practices of nematode management; integrated nematode management.

Practical

Studies on kinds of nematodes- free-living, animal, insect and plant parasites; soil sampling, nematode extraction from soil; extraction of migratory endoparasites, staining for sedentary semiendoparasite and endoparasites; examination of different life stages of important plant parasitic nematodes, their symptoms and histopathology.

Suggested Readings

Dropkin VH. 1980. *An Introduction to Plant Nematology*. John Wiley & Sons, New York.

Perry RN & Moens M. 2006. *Plant Nematology*. CABI, London.

Singh RS & Sitaramaiah K. 1994. *Plant Pathogens – Nematodes*. Oxford & IBH, New Delhi.

Thorne G. 1961. *Principles of Nematology*. McGraw Hill, New Delhi.

Walia RK & Bajaj HK. 2003. *Text Book on Introductory Plant Nematology*. ICAR, New Delhi.

NEMA 512 NEMATOLOGICAL TECHNIQUES © 1+2

Objective

Understanding the principles, theoretical aspects and developing skills in nematological techniques.

Theory

UNIT I

Principles and use of light, scanning and transmission electron microscopes, and other laboratory equipments.

UNIT II

Survey and surveillance methods; collection of soil and plant samples; techniques for extraction of nematodes from soil and plant material; estimation of population densities.

UNIT III

Killing, fixing, clearing, preservation and mounting nematodes; measurements, preparation of perineal patterns, vulval cones of cyst nematodes, en-face views and body section of nematodes.

UNIT IV

In vitro and *in vivo* culturing techniques of plant parasitic, bacteriophagous, mycophagus and omnivorous nematodes.

UNIT V

Staining nematodes in plant tissues; microtomy for histopathological studies; collection of plant root exudates and their bioassay; preparation of plant materials for exhibition.

UNIT VI

Application of molecular techniques in Nematology.

Practical

Collection of soil and plant samples; extraction of nematodes from soil by Baermann funnel, sieving and decanting, elutriation and sugar centrifugal methods; extraction of cysts from soil; extraction of nematodes from plant material; estimation of population densities; staining plant material for nematodes; killing and fixing nematodes, clearing nematodes by slow and Seinhorst's methods; preparation of temporary and permanent mounts; measurements, drawing, microphotography, special preparation of nematodes - perineal patterns, vulval cones, en-face and body sections; collection of root exudates, preparation of exhibits of nematode diseased plant material, *in vitro* culturing techniques of nematodes- callous culture, excised root and carrot disc techniques.

Suggested Readings

Ayoub SM. 1981. *Plant Nematology – An Agricultural Training Aid*. NemaAid Publications.

Barker KR, Carter CC & Sasser JN 1985. *An Advanced Treatise on* Meloidogyne. Vol. II. *Methodology*. International *Meloidogyne* Project, NCSU, Raliegh.

Southey JF. 1986. *Laboratory Methods for Work with Plant and Soil Nematodes*. HMSO, London.

NEMAT 513 **2+1**

STRUCTURAL AND FUNCTIONAL ORGANIZATION OF NEMATODES ©

Objective

Familiarization with structural organization of nematode body so as to enable the students to understand biology, physiology and classification of nematodes.

Theory

UNIT I

Introduction and general organization of nematode body.

UNIT II

Morphology and anatomy of nematode cuticle, hypodermis, musculature and pseudocoelom.

UNIT III

Digestive system- structural variations of stoma, oesophagus, intestine and rectum in nematodes.

UNIT IV

Reproductive system- terminology and variations in female and male reproductive systems, nemic eggs and sperms, types of reproduction, spermatogenesis and oogenesis.

UNIT V

Types and structure of excretory-secretory systems; nervous system and associated sense organs.

Practical

Studies on variations in nematode shapes and sizes, morphological details of cuticle, cuticular markings and ornamentation, variations in stoma, oesophagus, rectum; types and parts of female and male reproductive systems, sense organs, and excretory system.

Suggested Readings

Bird AF & Bird J. 1991. *The Structure of Nematodes*. Academic Press, New York.

Chitwood BG & Chitwood MB. 1950. *An Introduction to Nematology*. Univ. Park Press, Baltimore.

Maggenti AR. 1981. *General Nematology.* Springer-Verlag, New York.

Malakhov VV. 1994. *Nematodes: Structure, Development, Classification and Phylogeny*. Smithsonian Institution Press, Washington DC.

Jairajpuri,M.S. 2002. Nematode Structure. Impression Quality Printers,Satya Apartment, Hyderabad

PRINCIPLES OF TAXONOMY

NEMAT514/ENT503
3+0

Objective

To sensitize the students on the theory and practice of classifying organisms and the rules governing the same.

Theory

UNIT I

Introduction to history and principles of systematics and importance. Levels and functions of systematics. Identification, purpose, methods-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

Nomenclature: Common vs Scientific names. International Code of Zoological Nomenclature, criteria for availability of names, validity of

names. Categories of names under consideration of ICZN. Publications, Principles of priority, and homonymy, synonymy, type concept in zoological nomenclature. Speciation, anagenesis vs cladogenesis, allopatric, sympatric and parapatric processes.

Suggested Readings

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book.* John Wiley & Sons, New York.

Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH, New Delhi.

Mayr E. 1971. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.

Quicke DLJ. 1993. *Principles and Techniques of Contemporary Taxonomy*. Blackie, London.

NEMAT 521 CLASSIFICATION OF NEMATODES© 2+1

Objective

Development of skills in the identification of plant parasitic nematodes up to genera and species levels.

Theory

UNIT I

Principles of nematode systematics and its importance.

UNIT II

Placement of nematodes in Animal Kingdom and comparison with related organisms.

UNIT III

Classification of Phylum Nematoda- Orders of Class Adenophorea and Secernentea; Diagnosis of Order Tylenchida- Suborder Tylenchina, Hoplolaimina and Criconematina; Infraorders Tylenchata and Anguinata- their families and genera.

UNIT IV

Diagnosis of genera and families of Suborders Tylenchina, Hoplolaimina and Criconematina.

UNIT V

Orders Aphelenchida, Dorylaimida, Enoplida, Rhabditida with emphasis on economically important taxa.

Practical

Identification of common plant parasitic nematodes belonging to Orders Tylenchida, Dorylaimida, Aphelenchida and Enoplida up to generic level; and up to species level for major nematode pests (root-knot, cyst nematodes, reniform namtode, stunt nematode etc.) of crops. Identification of EPNs belonging to Order Rhabditida.

Suggested Readings

DeCramer W. 1995. *The Family Trichodoridae*: *Stubby Root and Virus Vector Nematodes*. Kluwer Academic Press, Dordrecht.

Geraert E. 2006. *Tylenchida*. Brill.

Hunt DJ. 1993. Aphelenchida, Longidoridae and Trichodoridae – their Systematics and Bionomics. CABI, Wallingford.

Siddiqi MR. 2000. *Tylenchida: Parasites of Plants and Insects*. 2nd Ed. CABI, Wallingford.

Jairajpuri,M.S. and Rahman,P.F. 2001. Nematode Taxonomy Impression Quality Printers,Satya Apartment, Hyderabad

NEMA 522 NEMATODE DISEASES OF CROPS 2+1

Objective

To impart basic knowledge about the causal organism, nature of damage, symptoms and management of nematode diseases of agricultural and horticultural crops.

Theory

Diagnosis of causal organism, distribution, host range, biology and life cycle, nature of damage, symptoms, interaction with other organisms, and management of nematode diseases in different crops.

UNIT I

Cereal crops- Ear-cockle and tundu diseases of wheat, molya disease of wheat and barley; rice root nematode, rice root-knot and cyst nematode problems, ufra and white tip diseases of rice; lesion nematodes, cyst nematodes of maize.

UNIT II

Pulses, , Fibre, and Oilseed crops- Pigeon pea cyst nematode, root knot nematode, reniform nematode and lesion nematode.

UNIT III

Vegetable crops-root-knot disease, reniform nematode, potato cyst nematode; Nematode problems of protected cultivation.

UNIT IV

Fruit crops- root-knot disease, reniform nematode, slow decline of citrus. Mushroom- nematode problems.

UNIT V

Plantation, medicinal and aromatic crops- burrowing, root knot and lesion nematode problems.

Practical

Diagnosis of causal organisms; identification of different life cycle stages; study of symptoms and histopathology of nematode damage in different crops, study tours for field diagnosis of nematode problems.

Suggested Readings

Bhatti DS & Walia RK. 1992. *Nematode Pests of Crops*. CBS, New Delhi.

Evans AAF, Trudgill DL & Webster JM. 1994. *Plant Parasitic Nematodes in Temperate Agriculture*. CABI, Wallingford.

Luc M, Sikora RA & Bridge J. 2005. *Plant Parasitic Nematodes in Subtropical and Tropical Agriculture*. CABI, Wallingford.

Nickle WR. 1991. *Manual of Agricultural Nematology*. Marcel Dekker, New York.

Perry RN & Moens M. 2006. *Plant Nematology*. CABI, Wallingford.

EMAT 523 NEMATODE ECOLOGY 2+1

Objective

To understand the life of plant parasitic nematodes in their environment; their survival strategies, and how to exploit these for their control.

Theory

UNIT I

Definition and scope; components of environment; evolution of nematodes; ecological classification, prevalence, distribution and dispersal of nematodes.

UNIT II

Role of nematodes in the food web; habitat and niche characteristics; community analysis and population estimation models.

UNIT III

Effects of abiotic and biotic factors on nematodes.

UNIT IV

Environmental extremes and nematode behaviour- aggregation, swarming, orientation, feeding and reproduction. Survival strategies of nematodes in adverse environment and absence of host.

UNIT V

Modeling population dynamics and relations with crop performance; ecological considerations in nematode management, data interpretation and systems simulation.

Practical

Study of nematode fauna in varied agro-ecological systems, community analysis of nematode populations, laboratory exercises on influence of abiotic factors on movement and hatching, green-house experiments on effect of abiotic factors on nematode populations and plant growth.

Suggested Readings

Croll NA. 1970. *The Behaviour of Nematodes*: *The Activity, Senses and Responses.* Edward Arnold, London.

Croll NA & Mathews BE. 1977. *Biology of Nematodes.* Blackie, Glasgow. Lee DL. 2002. *The Biology of Nematodes.* Taylor & Francis, London.

Norton DC. 1978. *Ecology of Plant Parasitic Nematodes*. John Wiley.

Poinar G. 1983. *Natural History of Nematodes.* Prentice Hall, Englewood Cliffs.

Wallace HR. 1973. *Nematode Ecology and Plant Disease*. Edward Arnold, London.

PRINCIPLES OF INTEGRATED PEST MANAGEMENT

NEMA 524/ ENT 510 2+1

Objective

To familiarize the students with principles of insect pest management, including concept and philosophy of IPM. Train students in computation of ETL, implementing IPM programmes.

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 and mechanical methods; pest survey and surveillance, forecasting, types of surveys including remote sensing methods, factors affecting surveys.

UNIT IV

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.

Suggested Readings

Dhaliwal GS & Arora R. 2003. *Integrated Pest Management – Concepts and Approaches.* Kalyani Publ., New Delhi.

Dhaliwal GS, Ram Singh & Chhillar BS. 2006. *Essentials of Agricultural Entomology.* Kalyani Publ., New Delhi.

Flint MC & Bosch RV. 1981. *Introduction to Integrated Pest Management.* 1st Ed., Springer, New York.

Horowitz AR & Ishaaya I. 2004. *Insect Pest Management: Field and*

Protected Crops. Springer, New Delhi.
Ignacimuthu SS & Jayaraj S. 2007. *Biotechnology and Insect Pest Management*. Elite Publ., New Delhi.
Norris RF, Caswell-Chen EP & Kogan M. 2002. *Concepts in Integrated Pest Management.* Prentice Hall, New Delhi.
Subramanyam B & Hagstrum DW. 1995. *Integrated Management of Insects in Stored Products.* Marcel Dekker, New York.

NEMAT 531 NEMATODE BIOLOGY AND PHYSIOLOGY 2+1

Objective

To develop understanding of life cycle patterns, feeding and metabolic processes in phytonematodes which have implications in their management.

Theory

UNIT I

Host finding and invasion, feeding, hatching, moulting; survival and life cycle patterns in different types of nematodes.

UNIT II

Types of reproduction, gametogenesis, embryogenesis and post embryogenesis.

UNIT III

Chemical composition of nematodes, hydrolytic enzymes, pseudocoelome and function of transport, respiration.

UNIT IV

Physiology of digestive system, intermediary metabolism.

UNIT V

Osmoregulation, physiology of excretory-secretory and neuromuscular systems.

Practical

Studies on embryogenesis and post-embryogenesis, hatching, moulting, life cycle development, feeding, enzymatic assay by electrophoresis.

Suggested Readings

Croll NA. 1970. *The Behaviour of Nematodes: The Activity, Senses and Responses.* Edward Arnold, London.
Croll NA & Mathews BE. 1977. *Biology of Nematodes.* Blackie, Glasgow.
Lee DL. 2002. *The Biology of Nematodes.* Taylor & Francis, London.
Lee DL & Atkinson H J. 1976. *Physiology of Nematodes*. MacMillan, London.
Perry RN & Wright DJ. 1998. The Physiology and Biochemistry of Free-living and Plant Parasitic Nematodes. CABI, Wallingford.
Wallace HR. 1963. The Biology of Plant Parasitic Nematodes. Edward Arnold, London.

NEMAT 532 NEMATODE INTERACTIONS WITH OTHER ORGANISMS 2+1

Objective

To understand the role of nematodes in disease complexes involving fungal, bacterial, viral and other organisms.

Theory

UNIT I

Concept of interaction and its importance in disease complexes and their management involving nematode and other organisms.

UNIT II

Interaction of plant parasitic nematodes with wilt causing fungal pathogens.

UNIT III

Interaction of plant parasitic nematodes with root rot and other fungal pathogens.

UNIT IV

Interaction of plant parasitic nematodes with bacterial pathogens, other nematode species and arthropods.

UNIT V

Virus transmission by nematodes.

Practical

Green-house experiments to study the role of plant parasitic nematodes in wilt/rot causing fungal and bacterial pathogens.

Suggested Readings

Khan MW. 1993. *Nemic Interactions*. Chapman & Hall, New York.
Lamberti F, Taylor CE & Seinhorst JW. 1975. *Nematode Vectors of Plant Viruses.* Plenum Press, London.
Sasser JN & Jenkins WR. 1960. *Nematology*: *Fundamentals and Recent Advances with Emphasis on Plant Parasitic and Soil Forms*. Eurasia Publ. House, New Delhi.

NEMAT 533 NEMATODE MANAGEMENT 2+1

Objective

To impart comprehensive knowledge about the principles and practices of nematode management.

Theory

UNIT I

Concepts and history of nematode management; crop loss estimation, ecological and socio-economic aspects, cost-benefit ratios and pest risk analysis.

UNIT II

Chemical methods- nematicides, their types, classification, mode of action, applicators and application methods, antidotes, and economizing nematicidal use.

UNIT III

Cultural practices- crop rotations and cropping sequences, fallowing, flooding, soil solarisation, time of sowing, organic amendments of soil, bio-fumigation, antagonistic and trap crops, sanitation etc. Physical methods- use of heat, hot water treatment and other methods of disinfestations of planting material.

UNIT IV

Biological methods- concepts and terminology, use of predators and parasites as biological control agents, their mass multiplication and field use; phytotherapeutic methods – use of antagonistic plants and antinemic plant products.

UNIT V

Genetic methods- plant resistance; legal methods- quarantine regulations; integrated nematode management- concepts and applications.

Practical

In vitro screening of synthetic chemicals and plant products for

nematicidal activity, and their application methods; methods for screening of crop germplasm for resistance against nematodes, laboratory exercises on biocontrol potential of fungal, bacterial parasites, and predacious fungi and nematodes.

Suggested Readings

Bhatti DS & Walia RK. 1994. *Nematode Pest Management in Crops*. CBS, New Delhi.

Brown GL. 1977. *The Nemtode Destroying Fungi*. CBP, Guelph.

Brown RH & Kerry BR. 1987. *Principles and Practice of Nematode Control in Crops*. Academic Press, Sydney.

Chen ZX, Chen SY& Dickson DW. 2004. *Nematology: Advances and Perpectives. Vol. II: Nematode Management and Utilization.* CABI, Wallingford.

Perry RN & Moens M. 2006. *Plant Nematology*. CABI, Wallingford.

Starr JL, Cook R & Bridge J. 2002. *Plant Resistance to Parasitic Nematodes.* CABI, Wallingford.Whitehead AG. 1997. *Plant Nematode Control*. CABI, Wallingford.

NEMAT 534 BENEFICIAL NEMATODES 2+1

Objective

To sensitize about the use of nematodes for the biological control of insect pests of crops, and application of some nematodes as biological models and as indicators of environmental pollution.

Theory

UNIT I

Beneficial nematode fauna- predators, parasites of insects, molluscs and other pests; Entomophilic nematodes- important groups, types of nematode-insect associations; taxonomic characteristics of nematode parasites of insects.

UNIT II

Host-parasite relations and life cycle of mermithids, entaphelenchids, thelastomids, sphaerularids and tylenchids.

UNIT III

Entomopathogenic nematodes- *Steinernema* and *Heterorhabditis,* their morphological characteristics, taxonomic status, biology and mode of action.

UNIT IV

Entomopathogenic nematodes- mass multiplication techniques, formulations, field applications and efficacy, success stories.

UNIT V

Nematodes as biological models, nematodes as indicators of pollution, role of nematodes in organic matter recycling.

Practical

Isolation, identification, mass rearing and application methods of entomopathogenic nematodes.

Suggested Readings

Gaugler R & Kaya HK. 1990. *Entomopathogenic Nematodes in Biological Control*. CRC Press, Boca Raton, Florida.

Gaugler R. 2002. *Entomophilic Nematology*. CABI, Wallingford.

Grewal PS, Ehlars RU & Shapiro DI. 2005. *Nematodes as Biocontrol Agents*. CABI, Wallingford.

Jairajpuri MS & Khan MS. 1982. *Predatory Nematodes (Mononchida)*. Associated Publ. Co., New Delhi.

Wood WB. 1998. *The Nematode* Caenorhabditis elegans. Cold Spring Harbor Press.

Woodring JL & Kaya HK. 1988. *Steinernematid and Heterorhabditid Nematodes: A Handbook of Techniques*. Southern Coop. Bull., Ark. Ag. Ext. Sta.

Zuckerman BM. (Ed.). 1980. *Nematodes as Biological Models*. Vols. I, II. Academic Press, New York.

www2.oardc.ohio-state.edu/nematodes

DISEASE RESISTANCE IN PLANTS

NEMAT535/ PL PATH 513 2+1

Objective

To acquaint with disease resistance mechanisms in plants.

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, allelochemicals, 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.

Practical

Screening of lines/germplasm against root knot, reniform and cyst nematode.

Suggested Readings

Dallice M *et al*.1996. *Molecular Aspects of Pathogenicity and Resistance: Requirement for Signal Transduction.* APS, St Paul, Minnesota.

Deverall BJ. 1977. *Defence Mechanisms in Plants*. Cambridge Univ. Press, Cambridge, New York.

Parker J. 2008. *Molecular Aspects of Plant Diseases Resistance*. Blackwell Publ.

Robinson RA. 1976. *Plant Pathosystems*. Springer Verlag, New York.

Singh BD. 2005. *Plant Breeding – Principles and Methods*. 7th Ed. Kalyani Publ., Ludhiana.

Van der Plank JE. 1975. *Principles of Plant Infection*. Academic Press, New York.

Van der Plank JE. 1982. *Host Pathogen Interactions in Plant Disease*. Academic Press, New York.

Van der Plank JE. 1984. *Disease Resistance in Plants*. Academic Press, New York.

NEMAT 536/ ENT 520 PLANT QUARANTINE 3+0

Objective

To acquaint the learners about the principles and the role of Plant Quarantine in containment of pests and diseases, plant quarantine

regulations and set-up.

Theory

UNIT I

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

UNIT II

Plant protection organization in India. Acts related to registration of pesticides and transgenics. History of quarantine legislations, PQ Order 2003. Environmental Acts, Industrial registration; APEDA, Import and Export of bio-control agents.

UNIT III

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

UNIT IV

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

Suggested Readings

Rajeev K & Mukherjee RC. 1996. *Role of Plant Quarantine in IPM*. Aditya Books.

Rhower GG. 1991. Regulatory Plant Pest Management. In: *Handbook of Pest Management in Agriculture*. 2nd Ed. Vol. II. (Ed. David Pimental). CRC Press.

Ph.D

NEMAT 611 ADVANCES IN STRUCTURE AND SYSTEMATICS OF NEMATODES **2+1**

Objective

Studies on the ultrastructure of plant parasitic nematodes based on TEM and SEM, and appraisal of recent developments in their classification.

Theory

UNIT I

Ultrastructure of nematode body wall- cuticle, hypodermis and muscles; nematode feeding apparatus, and other parts of alimentary canal.

UNIT II

Ultrastructure of nematode sense organs, reproductive and excretory-secretory systems.

UNIT III

Principles and rules of nomenclature and classification; preparation of illustrations, keys and compendia for nematode species and other taxa.

UNIT IV Non-conventional approaches of nematode identification-molecular, biochemical, immunodiagnostic, molecular characterization and DNA finger-printing techniques.

UNIT V

Development of computer-based nematode identification programmes.

Practical

Detailed studies of morphological structures and identification of plant parasitic nematodes up to species level. Drawing and measurements of nematodes, preparation of compendia and keys. Identification of species/races of root-knot and cyst nematodes using PAGE.

Suggested Readings

Barrington EJW. 1967. *Invertebrate Structure and Function*. Nelson, Nairobi.

Blackwelder RE. 1967. *Taxonomy - A Text and Reference Book.* John Wiley & Sons, New York.

Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives. Vol. I. Nematode Morphology, Physiology*

and Ecology. CABI, Wallingford.
Geraert E. 2006. *Nematology Monographs and Perspectives*. Vol. IV. Brill.
International Commission of Zoological Nomenclature 1999. *International Code of Zoological Nomenclature* 4th Ed. The Natural History Museum, London.
Kapoor VC. 1983. *Theory and Practice in Animal Taxonomy*. Oxford & IBH, New Delhi.
Mayr E. 1969. *Principles of Systematic Zoology*. Tata McGraw-Hill, New Delhi.
Quicke DLJ. 1993. Principles and Techniques of Contemporary Taxonomy. Blackie, London.

NEMAT 612 ADVANCES IN NEMATODE MANAGEMENT 2+1

Objective

To keep abreast with latest developments and trends in nematode management.

Theory

UNIT I

Isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents- predacious and parasitic fungi; nematoxic fungal culture filtrates.

UNIT II

Isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents- parasitic and nematode antagonistic bacteria; predacious mites, predacious nematodes and entomopathogenic nematodes and their role.

UNIT III

Mass culturing, formulation, quality control, bio-safety and securuty and registration protocols of bio-control agents.

UNIT IV

Phytoalexins, allelochemicals, phytotherapeutic substances, novel nematicides, deployment of resistant varieties and non-host crops in nematode suppressive cropping systems, emergence of resistance breaking biotypes, recent regulatory provisions and methods, quarantine and disinfection.

UNIT V

Nematode management modules for integrated pest and disease

management in cropping systems. Nematode management options and approaches for organic farming and precision farming. Application of GIS and GPS technology for surveillance and management.

Practical

Green-house experiments on the efficacy of fungal and bacterial bio-control agents, botanicals.

Suggested Readings

Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives Vol. II. Nematode Management and Utilization.* CABI, Wallingford.

Jana BL. 2008. *Precision Farming*. Reseachco Books & Periodicals Pvt. Ltd., Delhi.

Lillesend TW, Kiefer RW & Chipman JW. 1979. *Remote Sensing and Image Interpretation*. John Wiley & Sons, New York.

Poinar GO Jr & Jansson H-B. 1988. *Diseases of Nematodes*. Vols. I, II. CRC Press, Boca Raton, Florida.

Starr JR, Cook R & Bridge J. 2002. *Plant Resistance to Parasitic Nematodes*. CABI, Wallingford.

Tarafdar JC, Priputhi KP & Mahesh Kumar 2007. *Organic Agriculture*. Scientific Publ., Jodhpur.

Upadhyaya RK, Walia RK & Dubey OP. 2004. *IPM Systems in Agriculture. Vol. IX. Phytonematology*. Aditya Books, New Delhi.

CURRENT TOPICS IN NEMATODE DISEASE DEVELOPMENT AND HOST RESISTANCE

NEMAT 621 **2+1**

Objective

To update knowledge on the recent research trends in the field of plant nematode relationships at genetic and molecular level.

Theory

UNIT I

Mechanisms of pathogenesis, cytological and biochemical changes induced by nematode feeding.

UNIT II

Plant defense systems, role of phytoalexins etc. against major plant parasitic nematodes.

UNIT III

Genetic basis of plant resistance to nematodes and identification of

resistance genes against economically important nematodes.

UNIT IV

Application of biotechnological methods in the development of nematode resistant crop cultivars; resistance markers; incorporation of resistance by conventional breeding and transgenic approaches.

UNIT V

Influence of microorganisms on plant- nematode interactions.

Practical

Microtomy for study of histopathological changes induced by important nematodes, screening techniques for assessment of resistance in crop germplasm against nematodes.

Suggested Readings

Barker KR, Pederson GA & Windham GL. 1998. *Plant and Nematode Interactions*. CABI, Wallingford.

Fenoll C, Grundler FMW & Ohl SA. 1997. *Cellular and Molecular aspects of Plant-Nematode Relationships*. Kluwer Academic Press, Dordrecht.

Lamberti F, Giorgi C & Bird D. 1994. *Advances in Molecular Plant Nematology*. Plenum Press.

NEMAT. 622. ADVANCED NEMATODE TECHNIQUES 3 (2+1)

Theory

Principles and use of light microscopy, electron microscopy (SEM, TEM), spectrophotometry and electrophoresis; Cytological, serological and molecular techniques and their applications in Nematology; *In vitro* culturing of phytophagous nematodes using callus, excised roots, carrot disc techniques; Culturing of mycophagous nematodes; Nematicidal residue analysis; Liquid and gas chromatography, HPLC; Experimental designs; Computer application for modelling and prediction of yield losses; Preparation, validation and presentation of research findings.

Practical

In vitro culturing of phytophagus nematodes by callus, carrot disc and excised root techniques; Culturing of mycophagous nematodes; Nematode enzymatic assays

employing electrophoretic techniques; Extraction and estimation of nematicidal residues insoil and plants.

Suggested Reading:

Southey, J.F. (1986) Laboratory Methods for work with Plant and Soil Nematodes. Ministry of Agriculture, Fisheries and Food, London.
Zukerman and Krusberg (1990) Plant Nematology Laboratory Manual. University of Massachusetts, USA
G. Swarup and D.R. Das Gupta. (1986) Plant Parasitic Nematodes of India – Problem and Progress, IARI, New Delhi.
Maggenti. General Nematology.
N.A. Croll. Behaviour of Nematodes, their activities, senses and their responses.

NEMAT-623 **3**
(2+1)

ADVANCES IN BIOLOGICAL CONTROL OF NEMATODES

Theory

History and concepts of biological control; Detailed discourses on isolation, identification, host specificity, mode of action, culturing and field application potential of promising bio-control agents (fungal and bacterial parasites, predacious nematodes and mites); Nematoxin producing organisms and antagonistic plants; Mass culturing, formulation, quality control, bio-safety and registration protocols of bio-control agents; use of botanicals and soil organic amendments and their mode of action.

Practical

Isolation, identification and *in vitro* testing for parasitic/predacious potential bio-control agents; Culturing, mass production, formulation and application techniques of selected bio-control agents, botanicals and organic amendments.

Suggested Reading:

- H.Decker. Plant Nematode and their Control.
- Swarup, G., Dasgupta, D.R. and Gill. J.S. 1995. Nematode Pest Management – An Appraisal of Eco-friendly Approaches. Nematological Society of India, IARI, New Delhi, India.

- Bhatti, D.S. and Walia, R.K. 1992. Nematode Pests of Crops. CBS Publishers and Distributors, New Delhi, India.
- Dasgupta,M.K. 1998. Phytonematology. Naya Prakash Publication, Calcutta

NEMAT-624 ADVANCED NEMATODE ECOLOGY 3 (2+1)

Theory

Principles and basis of nematode ecology; Community analysis and population estimation models; Role of nematodes in the food web, habitat and niche characteristics; Effects of biotic and abiotic stresses on host-parasite interaction; Environmental extremes and survival strategies of nematodes; Biochemical and molecular basis of nematode survival; Modelling of population dynamics in relation with crop performance; Ecological considerations in nematode management; Data interpretation and systems simulation.

Practical

Studies on distribution patterns, community analysis, population density v/s crop yield relationships; Effect of biotic and abiotic factors.

Suggested Reading:

- Evans, K. and Tudgrill, D.L. (1993). Plant Parasitic Nematode in temperate agriculture, CAB International, Wallingford,UK.
- Norton, D.C. (1978). Ecology of Plant Parasitic Nematodes. John Willey & Sons, Inc.New York.
- Wallace, H.R. (1963). The Biology of Plant Parasitic Nematodes. Edward Arnold, London.
- H.R. Wallace (1973). Nematode Ecology and plant Diseases. Alden &Mowbray Ltd. at The Alden Press, Oxford.
- N.A. Croll. Biology of Nematodes.

NEMAT 625 PHYSIOLOGICAL AND MOLECULAR NEMATOLOGY

2+1

Objective

Appraisal on the application of modern biotechnological tools in Nematology.

Theory

UNIT I

Cell biology- Structural and functional aspects; genetics and evolution in plant parasitism in nematodes.

UNIT II

Caenorhabditis elegans- a model system for gerontology, cytogenetics,
physiology, nutritional, toxicological and pharmacological studies; *Heterodera glycines* as a model for biology, proteomic and genomic studies.

UNIT III

Chemoreception, neurobiology, and biochemical basis of communication in nematodes, molecular basis of host recognition.

UNIT IV

Biochemical, genetical and molecular basis of plant nematode interaction; histopathological, cellular and molecular changes in host feeding cells, resistance genes and RNAi technology.

UNIT V

Biochemical and molecular basis of survival strategies in nematodes, molecular mechanism of host resistance against plant parasitic nematodes, molecular and novel approaches for nematode management.

Practical

Isolation and quantification of proteins from nematode juveniles and eggs; molecular weight determination of nematode protein; β-esterase polymorphism in root-knot nematode; nematode DNA isolation from juveniles and eggs; RFLP of nematode DNA; nematode DNA amplification using PCR for nematode identification, RNAi technology.

Suggested Readings

Chen ZX, Chen SY & Dickson DW. 2004. *Nematology: Advances and Perspectives. Vol. I. Nematode Morphology, Physiology and Ecology*. CABI, Wallingford.

Fenoll C, Grundler FMW & Ohl SA. 1997. *Cellular and Molecular aspects of Plant-Nematode Relationships*. Kluwer Academic Publ., Dordrecht.

Lamberti F, Giorgi C. & Bird D. 1994. *Advances in Molecular Plant Nematology*. Plenum Press.

Perry RN & Wright DJ. 1998. *The Physiology and Biochemistry of Free-living and Plant Parasitic Nematodes*. CABI, London.

Wood WB. 1988. *The Nematode* Caenorhabditis elegans. Cold Spring Harbor Press.

Zuckerman BM. 1980. *Nematodes as Biological Models*. Vols. I, II. Academic Press, New York.

PLANT BIOSECURITY AND BIOSAFETY

NEMA 626/ PL PATH 606 3+0

Objective

To facilitate deeper understanding on plant biosecurity and biosafety issues in agriculture.

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.

Suggested Readings

FAO Biosecurity Toolkit 2008. www.fao.org/docrep/010/a1140e/a1140e00.htm

Laboratory Biosecurity Guidance. http://www.who.int/csr/resources/publications/biosafety/WHO_CD S_EPR_2006.pdf

Grotto Andrew J & Jonathan B Tucker. 2006. *Biosecurity: A Comprehensive Action Plan.* http://www.americanprogress.org/kf/biosecurity_a_comprehensive_ action_plan.pdf

Biosecurity Australia.
www.daff.gov.au/ba;www.affa.gov.au/biosecurityaustralia

Biosecurity New Zealand. www.biosecurity.govt.nz

DEFRA.
www.defra.gov.uk/animalh/diseases/control/biosecurity/index.htm

Randhawa GJ, Khetarpal RK, Tyagi RK & Dhillon. BS (Eds.). 2001. *Transgenic Crops and Biosafety Concerns.* NBPGR, New Delhi.

Khetarpal RK & Kavita Gupta 2006. *Plant Biosecurity in India - Status and Strategy*. Asian Biotechnology and Development Review 9(2): 39-63.

Biosecurity for Agriculture and Food Production. http://www.fao.org/biosecurity/

NEMATOLOGY

List of Journals

- *Annals of Applied Nematology* - Society of Nematologists, USA
- *Current Nematology* -Bioved Research Society, Allahabad, India
- *Egyptian Journal of Agronematology* – Egyptian Society of Agricultural Nematology
- *Indian Journal of Nematology* - Nematological Society of India
- *International Journal of Nematology* - Afro-Asian Society of Nematologists, Luton
- *Japanese Journal of Nematology* -Japanese Nematological Society
- *Journal of Nematology* - Society of Nematologists, USA

- *Journal of Nematode Morphology and Systematics* –Jaen, Universidad de Jaen
- *Nematologia Brasiliera* – Brazilian Nematological Society
- *Nematologia Mediterranea* – Istituto per la Protezione delle Plante (IPP) – Sect. of Bari of the CNR, Italy
- *Nematology* -Brill Academic Publishers, UK
- *Nematropica* -Organization of Nematologists of Tropical America
- *Pakistan Journal of Nematology* -Pakistan Society of Nematologists
- *Russian Journal of Nematology* -Russian Society of Nematologists

e-Resources

- http://www.nematologists.org/ (The Society of Nematologists)
- http://nematology.ucdavis.edu/ (Deptt. of Nematology, Univ. of California, Davis)
- http://www.ifns.org/ (International Federation of Nematology Societies)
- http://www.inaav.ba.cnr.it/nemmed.html (Nematologia Mediterranea)
- http://nematode.unl.edu/Nemajob.htm (Nematology Employment Bulletin Board)
- http://nematode.unl.edu/ (University of Nebraska - Lincoln Nematology)
- http://nematode.unl.edu/wormsite.htm (Links to Other Nematology Resources)
- http://nematode.unl.edu/SON/jon.htm (Journal of Nematology)

- http://www.nematology.ucr.edu/ (Deptt. of Nematology, Univ. of California, Riverside)
- http://entnemdept.ifas.ufl.edu/ (Univ. of Florida, Entomology & Nematology Dept.)

- http://www.brill.nl/m_catalogue_sub6_id8548.htm (Nematology - journal)
- http://www.ars.usda.gov/main/site_main.htm?modecode=12752900 (Nematology Lab., USDA)
- http://flnem.ifas.ufl.edu/HISTORY/nem_history.htm (Nematology history)
- http://www.nematology.ugent.be/ (Nematology Unit, Ghent University)
- http://www.entm.purdue.edu/nematology/ (The Purdue Nematology Lab.)
- http://www.bspp.org.uk/ppigb/nematolo.htm#a-z (Links to Nematology labs)
- http://www.nem.wur.nl/UK/ (Laboratory of Nematology, Wageningen Univ.)
- http://onta.ifas.ufl.edu/ (The Organization of Nematologists of Tropical America)
- http://www.openjgate.org/Articlelist.asp?Source=1&Journal_ID=103267.(Nematology Newsletter)
- http://nematology.umd.edu/nematology.html (Plant Nematology Laboratory, Maryland)
- http://www.biology.leeds.ac.uk/nem/ (Plant Nematology Lab., University of Leeds)
- http://www.plantpath.iastate.edu/dept/labs/tylka/ (Iowa State University, Nematology Lab)
- http://nematologists.org.au/newsletters.html (Australasian Association of Nematologists)
- http://soilplantlab.missouri.edu/nematode/ (Plant Nematology Laboratory, Missouri)
- http://www.eumaine.ugent.be/ (European Master of Science in Nematology)
- http://www.jstage.jst.go.jp/browse/jjn (The Japanese Journal of Nematology)

Suggested Broad Topics for Master's and Doctoral Research

- Identification of key nematode pests emerging in regional agro-ecosystems
- Development of molecular diagnostic tools of phytonematodes
- Nematode problems of peri-urban and protected agriculture systems, and their management
- Role of nematodes in organic matter recycling
- Modeling nematode populations for disease forecasting and predicting yield losses
- Nematodes as indicators of environmental pollution
- Identification of cost effective nematode-suppressive cropping systems for specific agro-ecosystems
- Isolation, identification and characterization of phytochemicals for nematoxicity
- Disinfection of nematode-infected planting material through eco-friendly sanitary methods
- Characterization of molecular markers and genes governing resistance to key nematode pests
- Management of nematodes with antagonistic bacteria
- Bionomics of potential bio-control agents and their field efficacy
- Devising non-chemical methods of nematode management in mushroom cultivation
- Development of nematode management modules for IPM systems
- Field efficacy and formulation of entomopathogenic nematodes against foliar and soil-borne insect pests of crops
- Study of disease complex involving nematodes and other plant pathogens.

DEPARTMENT OF PLANT PHYSIOLOGY

PROGRAMMES

1 M.Sc. Minor and Supporting Courses
2 Ph.D.

Courses Offered:

M.Sc.

S.No.	Course No.	Title of the Course	CrHrs.
1	PPHY-511	Physiological aspects of Mineral Nutrition	3(2+1)
2	PPHY-512	Hormonal regulation of plant growth & development	3(2+1)
3	PPHY-521	Principles of Plant Physiology	3(2+1)
4	PPHY-522	Physiological & Molecular Response of Plants to Abiotic Stresses	3(2+1)

Ph.D.

S.No.	Course No.	Title of Course	Cr.Hrs.
1	PPHY-611	Post Harvest Physiology	3(2+1)
2	PPHY-622	Seed Physiology	3(2+1)

B.Sc.

S.No.	Course No.	Title of Course	Cr.Hrs.
1	PPHY-211	Crop Physiology	3(2+1)

DESCRIPTION OF COURSES

PPHY-211 : CROP PHYSIOLOGY 3(2+1)

Theory:

An introduction to plant physiology, plant cell- an introduction, laws of thermodynamics, diffusion and osmosis, the concept of water potential, cell water relation, absorption of water, Transpiration, stomatal physiology, Ascent of sap. Ion uptake and metabolic utilization of mineral ions, Deficiency of mineral ions in plants.

Photosynthesis, Respiration, Fat metabolism, Physiology of growth and development, Growth regulators, Physiological parameters influencing the productivity of major crops.

Practical:

Cell structure, process of diffusion, osmosis and plasmolysis, structure and distribution of stomata in monocot and dicot leaves, process of transpiration with the help of cobalt chloride paper and other methods, process of root pressure by exudation method and other manometer. Detection of certain essential micro and macro-mineral elements in crop plants.

Demonstration of the measurement of photosynthetic rates by infra-red gas analyzer, factors affecting the process of photosynthesis, separation of photosynthetic pigments by paper chromatography.

Detection of certain essential micro and macro-mineral elements in crop plants,

Process of aerobic respiration in germinated seed and alcoholic fermentation, tropism and movement.

Suggested Readings:

S.N. Pandey & B.K. Sinha (2004). Plant Physiology. Vikas Publisher.

Sushila M. Das (2004). The latest portfolio of theory & practical in plant physiology.

Arvind Kumar and S.S. Purohit (2005). Plant Physiology, Fundamental and application,
2nd Ed. AgroBotanical Publisher, BIKANER.

Narendra K.Gupta & Sunita Gupta(2005). Plant Physiology, Oxford IBH Publishing Co.

PPHY-511 : PHYSIOLOGICAL ASPECTS OF MINERAL NUTRITION 3(2+1)

Theory:

Overview of essential mineral elements.
Nutrient uptake by root cell and their transport and movement in developing grain.
Molecular mechanism of ion uptake, transport and their functional regulation.
Molecular physiology of micronutrients acquisition. Strategies plants adopt to acquire and transport minerals under deficit level.
Physiological and molecular mechanisms :underlying differential nutrients efficiency in crop genotypes.
Breeding crop-variety for improved nutrients efficiency. Plants response to mineral toxicity,

Practical:

Physiological and biological changes in plants under nutrients sufficiency and deficiency level.
Quantification of pigment level.
Enzyme activities.

Suggested Readings:

Barker, AB & Pilbeam DJ.2007. Hand book Plant Nutrition. CRC. Press

Epstein, E. 2007. Mineral Nutrition of Plants. John Wiley & sons.

PPHY-512 : HORMONAL REGULATION OF PLANT GROWTH AND DEVELOPMENT

3(2+1)
Theory:

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, Concepts of growth hormone.
Site of synthesis, biosynthesis pathway and metabolism and influence on plant growth development of individual group of hormone- Auxins, Gibberlins ,cytokinins, ABA, ethylene and brassinosteroids,
Hormone mutants and transgenic plants in understanding role of hormones.
Singnal perception, transduction and effect of functional gene level of different hormone-Auxins-cell elongation, Gebberllins-germination of dorment seeds, Cytokinines-cell division, retardation of senescences of plant parts, Abscisic acid-stomatal closure and induction of drought resistance, Ethylene- fruit ripening.
Interaction of hormone in regulation of plant growth and development processes, Rooting of cuttings, Flowering, Apical dominance, molecular aspects of control of reproductive growth and development.
Synthetic growth regulators- classification, their effect on plant growth and development. practical utility in agriculture and horticulture.

Practical:

Auxins effect on rooting of cuttings, abscission, apical dominance.
Gibberlline effect on germination of dormant seed.
Cytokinine effect on apical dominance and senescence.
ABA effect on stomatal movement.
Ethylene effect on breaking dormancy.

Suggested Readings:

Hopkins, WG & Huner NPA.2004. Introduction to plant physiology. John Wiley & sons.

Hota,Dharamvir. 2007.Synthetic plant growth regulators.

Basra. A.S.,2004.Plant Growth regulators in Agriculture and Horticulture, International Book Distributing Co.

PPHY-521 : PRINCIPLES OF PLANT PHYSIOLOGY 3(2+1)

Theory:

Cell organelles and their physiological functions, structure and physiological functions of cell wall, cell inclusions; cell membrane: structure and functions.

Soil and plant water uptake, water and its role in plants, properties and functions of water in the cell water relations, cell water terminology, water potential of plant cells.

Mechanism of water uptake by root, transport in root, aquaporins, movements of water in plants, Micorrhizal association on water uptake.

Water loss from plants : Evapo-transpiration. Transpiration, driving force for transpiration, plant factors influencing transpiration rate.

Stomata: structure and function, mechanism of stomatal movement, antitranspirants.

The role of mineral nutrition in plant metabolism: essential elements, classification based on functions of elements in plants.

Physiological and metabolic functions of mineral elements, critical levels, deficiency symptoms, nutrient deficiency and toxicity, foliar nutrition.

Photosynthesis and its importance in bio-productivity. Photochemical process, photochemical reactions, CO_2 reduction in calvin cycle, supplementary pathway of CO_2 fixation in C_4 and CAM plants and its significance.
Mitochondrial respiration
Growth and differentiation, Hormonal concept of growth and differentiation, plant growth hormones and their physiological role, synthetic growth regulators, growth retardants, apical dominance, senescence, fruit growth, abscission.

Practical:

Measurement of plant water status: RWC, WSD, VPD.
Measurement of transpiration rate: Porometry study, influence of ABA on stomatal closing.
Deficiency systems of nutrients.
Estimation of chlorophyll and chlorophyll stability index.
Oxygen evolution during photosynthesis.

Suggested Readings:

Hopkins, W.G. & Huner N.P.A.2004 Introduction to plant physiology. John Wiley& Sons.

Salisbury F.B. & Ross, C.1992. Plant Physiology, IVth Edition, Wardsworth Publication.

Mukherji, S. & Ghosh, A. K. 2005.Plant Physiology. New Central Book Agency ,Kolkata.

PHY-522: PHYSIOLOGICAL AND MOLECULAR RESPONSES OF PLANTS TO
ABIOTIC STRESSES 3(2+1)

Theory:

Response of plants to abiotic stress: Abiotic stresses affecting plants productivity. Basic principles of crop improvement programme under stress, Interaction between biotic and abiotic stress.

Drought- characteristic features, water potential in the soil- Plant air continuum, Development of water deficits, energy balance concept.
Physiological process affected by drought, drought resistance mechanism,
Molecular response to water deficit: stress perception, Expression of regulatory and genes and significance of gene products.
Stress and hormones- ABA as a signaling molecule, Cytokinin as a negative singnal. Oxidative stress- ROS, Role of scavenging system (SOD, Catalase etc.).
High temperature stress tolerance mechanism.
Chilling stress: Effect on physiological processes.
Salinity : Salt tolerance mechanism.

Practical:

Measurement of drought tolerance on the basis of chlorophyll stability index,
Measurement of drought tolerance on the basis of cell membrane stability,
Measurement of salt tolerance on the basis of cell membrane stability
Effect of drought on transpiration
Effect of salinity on transpiration

Suggested Readings

J. Levitt 1981. Plant responses to environmental stresses (vol. I &II). Academic Press, New York & London

Dwivedi & Dwivedi (2005) Physiology of abotic stress in plants. Agro bios. India

Paul.J.Kramer, (1983). Water relations of Plants. Academic Press.

Panda S.K.(2002) Advances in Stress Physiology of Plants. Scientific Publishers, Jodhpur

PPHY-611 : POST HARVEST PHYSIOLOGY 3(2+1)

Theory:

Senescence: Factors influencing senescence, ripening and post harvest life of flower, vegetables and seeds.
Molecular mechanism of senescence and ageing, senescence associated genes.
Functional and ultra-structural changes in chloroplast membrane, mitochondria and cell wall during senescence and ripening.
Role of ethylene in senescence and ripening.
Biotechnological approaches to manipulate ethylene biosynthesis and action.

Practical:

Physiological and biological changes during senescence and ripening.
Determination of scavenging enzymes like SOD, PPO, Peroxidase, Catalase, Acid-p etc,
Estimation of ripening related enzyme activity.
Estimation of chlorophyll content.
Measurement of dark and alternate respiration rate during senescence and ripening.

Suggested Reading:

Jeffrey K Brecht & Weichmann J. 2003. Post harvest physiology and pathology of vegetables. CRC Press.

PHY-622 : SEED PHYSIOLOGY
3(2+1)

Theory:

Seed and fruit development, abortion, proximate mechanism of abortion .Hereditary and environmental effects on seed development.
Importance of seed, seed structure and function, physiological and biochemical changes during seed and fruit development and abortion.
Seed storage: resources and sources of assimilation for seed development.
Pathway of movement of assimilates in developing grains of monocots, chemical composition of seed, storage of carbohydrates, proteins and fats in seed and their biosynthesis.

Seed respiration, mitochondrial activity, seed ageing, mobilization of stored food, oxidation 0f starch, protein and fats, and utilization of breakdown products by embryonic axis.
Seed viability, seed vigour, seed dormancy, types and regulation
Means to overcome seed dormancy.

Practical:

Determination of seed protein
Alpha-amylase activity in germinating seeds.
Role of GA in inducing alpha-amylase activity, protease, and lipase activity in germinating seed.
Seed viability test and accelerated ageing test.

Suggested Readings:

Srivastav, LM. Plant Growth and Development: Hormones and Environment. Academic Press.

Bewley, J.D. & Black, M. 1985. Seed Physiology of Development and Germination.
Plenum Publication.

Copeland, L.O. & McDonald M.B. Principles of Seed Sciences and Technology. Burgers
Publ.Co.

DEPARTMENT OF AGRICULTURAL CHEMISTRY AND SOIL SCIENCE
RAJASTHAN COLLEGE OF AGRICULTURE, UDAIPUR

PROGRAMMES

1. M. Sc.
2. Ph. D.

Course Requirement

M. Sc.

Field of specialization	Soil Chemistry, Soil Fertility and Fertilizer Use, Soil Mineralogy, Soil genesis and Soil survey, Basics of Soil Biology and Biochemistry, Soil, Water and Air Pollution, Soil Physical properties, Problem soils, Analytical techniques.
Core courses	SCHEM 511, SCHEM 512, SCHEM 513, SCHEM 521,
Optional courses	SCHEM 522, SCHEM 523, SCHEM 524, SCHEM 525, SCHEM 531, SCHEM 532, SCHEM 533, SCHEM 534, SCHEM 535, SCHEM 536
Minor & Supporting course	STAT 511, PPHYS 511, AGRON 521 or as per decision of advisory committee in view of research problem
Non-credit Compulsory courses	PGS 521
Deficiency courses	NIL or as deemed suitable by advisory committee

Ph. D.

Field of specialization	Soil Fertility and Nutrient use in Crop Production, Soil Physics, Physical Chemistry of Soils, Soil Organic Matter, Micropedology, Land Use Planning
Core courses	SCHEM 611, SCHEM 612
Optional courses	SCHEM 613, SCHEM 621, SCHEM 622, SCHEM 623
Minor &	STAT 612, PPHYS 511, PPHYS 522 or as per decision of

Supporting course	advisory committee in view of research problem
Non-credit Compulsory courses	NIL
Deficiency courses	NIL or as deemed suitable by advisory committee

Description of courses

Undergraduate courses

1.	**SCHEM -111**	**INTRODUCTION TO SOIL SCIENCE**	**3 (2+1)**

1. SYLLABUS

A. THEORY

Soil: Pedological and edaphological concepts. Origin of 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 and porosity and their significance and manipulation. Soil colour. Soil water, Retention and potentials, Soil moisture constants, Movement of soil water, Infiltration, Percolation, Permeability, Drainage. Methods of determination of soil moisture. Thermal prosperities of soils, Soil temperature. Soil air, Gaseous exchange, Influence of soil temperature and air on plant growth. Soil colloids : Properties, nature, types and significance; Laayer silicate clays, and sources of charges. Adsorption of ions, Ion exchange, CEC & AEC, Soil reaction and buffering capacity. Factors influencing ion exchange and its Significance. Problem soils –acid, salt affected and calcareous soils, characteristics. Reclamation – mechanical, chemical and biological methods. Irrigations water – Quality of irrigation water and its appraisal. Indian standards for water quality. Use of saline water for agriculture.

B. PRACTICAL

Collection and processing of soil sample. Identification of rocks and minerals. Determination of bulk density and particle density, Soil moisture determination, Soil moisture constraints – Field capacity, permanent wilting point, Water holding capacity, Infiltration rate, Soil texture and mechanical analysis, Soil temperature, Soil analysis for CEC, pH, EC, soluble cations and anions.

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2.	**SCHEM -121**	**SOIL CHEMISTRY AND SOIL FERTILITY AND NUTRIENT MANAGEMENT**	**2 (1+1)**

1. SYLLABUS

A. THEORY

Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Measures to overcome deficiencies and toxicities, nutrient availability to plants in Acid, salt affected and calcareous soils: Concept of soil fertility, different approaches/ methods for soil fertility evaluation – Biological method. Plant analysis method: DRIS methods, critical levels in plants. Rapid tissue tests. Indicator plants. Soil analysis methods: critical levels of different nutrients in soil. Soil test based fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Integrated nutrient management.

B. PRACTICAL

Analytical chemistry – Basic concepts, techniques and calculations, Principles of analytical instruments and their calibration and applications,

Estimation of available N, P, K, S, Zn and Fe in soil, Estimation of N, P and K in plants.

.	**SCHEM -211**	**MANURES AND FERTILIZERS**	**2 (1+1)**

1. SYLLABUS

A. THEORY

Soil organic matter, composition, decomposability, C: N ratio. Soil biology, Biomass, Soil organisms and their beneficial and harmful roles. 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, Chemistry of manufacturing and properties of major nitrogenous (ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), potassic and complex fertilizers, their fate and reactions in the soil, Secondary and micronutrients fertilizers, amendments, Fertilizer Control Order, Fertilizer storage; Important Biofertilizers and their advantage.

B. PRACTICAL

Determination of organic carbon and microbial biomass C, N and P. Total nitrogen and phosphorus in manures / composts – Ammoniacal and nitrate nitrogen – Water soluble P_2O_5, potassium, calcium, sulphur and zinc contents of fertilizers, Adulteration in fertilizer.

4.	**SCHEM -221**	**SOIL SURVEY, LAND USE PLANNING AND REMOTE SENSING**	**2 (1+1)**

1. SYLLABUS

A. THEORY

Soil profile development, soil survey: Significance and purpose of soil survey, methods of soil survey mapping. Types of soil surveys: Detailed, Reconnaissance, and Detailed – reconnaissance soil survey, Land use planning: Land capability classification, Soil mapping units, Soil survey interpretations and soil survey report. Major soil groups of India with special reference to Rajasthan. Soil taxonomy – a comprehensive US system of soil classification. Remote sensing: concept of remote sensing, Aerial photography, Aerial and satellite sensor imaginary, image processing and interpretations.

B. PRACTICAL

Examinations and description of typical soil profile. Interpretation of topographic map and delineation of physiographic boundaries based on important characters, typifying pedon excavation, examination and classification, interpretation of the identified soil characteristics and their evaluation for land use planning. Preparation of the soil survey report, interpretation of remote sensing information.

Postgraduate courses

SCHEM 511 SOIL CHEMISTRY 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.

Theory

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; soil organic matter - fractionation of soil organic matter and different fractions, 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, clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange – innersphere 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, ECe, 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, Eh by the use of Eh-pH meter and conductivity meter
- Determination of organic matter fractions – HA, FA, Lignin & humus
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Determination of titratable acidity of an acid soil by BaCl2-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley & Sons.

McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.

Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.

Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.

Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.

Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.

Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SCHEM 512 SOIL FERTILITY AND FERTILIZER USE
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.

UNIT X

Principles and application of colorimeter, Flame-photometry and atomic absorption spectroscopy

Practical

- Chemical analysis of soil for total and available nutrients (Total and available N, P, K, Cu, Mn, Zn, Fe and S)
- Analysis of plants for essential elements (N, P, K, Cu, Mn, Zn, Fe and S)

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*.C RC Press.

Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.

Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.

Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality.* 2nd Ed. CRC Press.

Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.

Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.

Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

.SCHEM 513 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY

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

Factors of soil formation, soil forming processes; weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT IV

Concept of soil individual; soil classification systems – historical developments and modern systems of soil classification with special emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.

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, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT VI

Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land 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

- 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 for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi

Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.

USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.

Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.

Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.

Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

SCHEM 514 RADIOISOTOPES IN SOIL AND PLANT STUDIES
2+1

Objective

To train students in the use of radioisotopes in soil and plant research

Theory

UNIT I

Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter

UNIT II

Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography

UNIT III

Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency; carbon dating

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 32P/ 65Zn
- Use of neutron probe for moisture determination
- Sample preparation and measurement of 15N enrichment by mass spectrophotometery/ emission spectrometry

Suggested Readings

Comer CL. 1955. *Radioisotopes in Biology and Agriculture: Principles and Practice*. Tata McGraw Hill.
Glasstone S. 1967. *Source Book on Atomic Energy*. East West Press.
Michael FL & Annunziata. 2003. *Handbook of Radioactivity Analysis*. Academic Press.

SCHEM 521 SOIL BIOLOGY AND BIOCHEMISTRY 2+1

Objective

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

Theory

UNIT I

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere and rhizosphere; 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, humus formation; cycles of important organic nutrients.

UNIT IV

Biodegradation of organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V

Preparation and preservation 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. BIS standards for quality control.

Practical

- Determination of soil microbial population
- Soil microbial biomass (C, N and P)

• Fractionation of organic matter and functional groups
• Soil enzymes
• Measurement of soil microbial processes such as nitrification, N2 fixation, S oxidation, P solubilization

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.
Burges A & Raw F. 1967. *Soil Biology*. Academic Press.
McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.
Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.
Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.
Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.
Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. LBS & McGraw Hill.
Stotzky G & Bollag JM. 1993. *Soil Biochemistry.* Vol. VIII. Marcel Dekker.
Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SCHEM 522 SOIL, WATER AND AIR POLLUTION 2+1

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Objective

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

Theory

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human
beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides – their classification, behavior in soil and effect on soil microorganisms.

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 in contaminated soils and plants

• Management of contaminants in soil and plants to safeguard food safety

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect.* CRC Press.

Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience.

Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.

Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. AnnArbor Science Publ.

SCHEM 523 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES 2+1

Objective

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

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, 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-statisticaltechniques of evolution of soil variability. 95

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 geostatistical 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

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.

Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.

Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.

Star J & Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

SCHEM 524 GEOMORPHOLOGY AND GEOCHEMISTRY 2+0

Objective

To impart knowledge about the landforms, physiography and morphology of the earth surface, and distribution and weathering elements in the earth crust.

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 igration of elements; geochemistry of major and micronutrients and trace elements.

Suggested Readings

Brikland PW. 1999. *Soils and Geomorophology*. 3rd Ed. Oxford Univ. Press.

Likens GE & Bormann FH. 1995. *Geochemistry*. 2nd Ed. Springer Verlag.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

SCHEM 525 SOIL EROSION AND CONSERVATION 2+1

Objective

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

Theory

UNIT I

History, distribution, identification and description of soil erosion problems in India.

UNIT II

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as 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; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

• Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, 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

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.

Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.

Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.

Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.

Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

SCHEM 531 SOIL PHYSICS 2+1

Objective

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

Theory

UNIT I

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II

Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III

Soil consistence; dispersion and workability of soil; 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 (Gravemetric & Moisture meter)
- Measurement of soil-water potential by using tensiometer and gypsum blocks
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of bulk density by core sampler methods
- Soil temperature measurements.

• Estimation of water balance components in bare and cropped fields.

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.
Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.
Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.
Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.
Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.
Hillel D. 1998. *Environmental Soil Physic*s. Academic Press.
Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.
Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley- Interscience.
Kohnke H. 1968. *Soil Physics*. McGraw Hill.
Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SCHEM 532 MANAGEMENT OF PROBLEM SOILS AND WATERS 2+1

Objective

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

Theory

UNIT I

Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept 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; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.

UNIT VI

Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

• Characterization of acid, acid sulfate, salt-affected and calcareous soils

• Determination of cations (Na^{+}, K^{+}, Ca^{++} and Mg^{++}) in ground water and soil samples

• Determination of anions (Cl^{-}, $SO4^{--}$, $CO3^{--}$ and $HCO3^{-}$) in ground waters and soil samples

• Lime and gypsum requirements of acid and sodic soils

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

Approved courses
SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
UG PROGRAMME

1.	**SCHEM -111**	**INTRODUCTION TO SOIL SCIENCE**	**3 (2+1)**

1. SYLLABUS

A. THEORY

Soil: Pedological and edaphological concepts. Origin of 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 and porosity and their significance and manipulation. Soil colour. Soil water, Retention and potentials, Soil moisture constants, Movement of soil water, Infiltration, Percolation, Permeability, Drainage. Methods of determination of soil moisture. Thermal prosperities of soils, Soil temperature. Soil air, Gaseous exchange, Influence of soil temperature and air on plant growth. Soil colloids : Properties, nature, types and significance; Laayer silicate clays, and sources of charges. Adsorption of ions, Ion exchange, CEC & AEC, Soil reaction and buffering capacity. Factors influencing ion exchange and its Significance. Problem soils –acid, salt affected and calcareous soils, characteristics. Reclamation – mechanical, chemical and biological methods. Irrigations water – Quality of irrigation water and its appraisal. Indian standards for water quality. Use of saline water for agriculture.

B. PRACTICAL

Collection and processing of soil sample. Identification of rocks and minerals. Determination of bulk density and particle density, Soil moisture determination, Soil moisture constraints – Field capacity, permanent wilting point, Water holding capacity, Infiltration rate, Soil texture and mechanical

analysis, Soil temperature, Soil analysis for CEC, pH, EC, soluble cations and anions.

2.	**SCHEM -121**	**SOIL CHEMISTRY AND SOIL FERTILITY AND NUTRIENT MANAGEMENT**	**2 (1+1)**

1. SYLLABUS

A. THEORY

Essential and beneficial elements, criteria of essentiality, forms of nutrients in soil, mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Measures to overcome deficiencies and toxicities, nutrient availability to plants in Acid, salt affected and calcareous soils: Concept of soil fertility, different approaches/ methods for soil fertility evaluation – Biological method. Plant analysis method: DRIS methods, critical levels in plants. Rapid tissue tests. Indicator plants. Soil analysis methods: critical levels of different nutrients in soil. Soil test based fertilizer recommendations to crops. Factors influencing nutrient use efficiency (NUE) in respect of N, P, K, S, Fe and Zn fertilizers. Integrated nutrient management.

B. PRACTICAL

Analytical chemistry – Basic concepts, techniques and calculations, Principles of analytical instruments and their calibration and applications, Estimation of available N, P, K, S, Zn and Fe in soil, Estimation of N, P and K in plants.

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3.	**SCHEM -211**	**MANURES AND FERTILIZERS**	**2 (1+1)**

1. SYLLABUS

A. THEORY

Soil organic matter, composition, decomposability, C: N ratio. Soil biology, Biomass, Soil organisms and their beneficial and harmful roles. 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, Chemistry of manufacturing and properties of major nitrogenous (ammonium sulphate, urea, calcium ammonium nitrate, ammonium nitrate, ammonium sulphate nitrate) phosphatic (single super phosphate, enriched super phosphate, diammonium phosphate, ammonium poly phosphate), potassic and complex fertilizers, their fate and reactions in the soil, Secondary and micronutrients fertilizers, amendments, Fertilizer Control Order, Fertilizer storage; Important Biofertilizers and their advantage.

B. PRACTICAL

Determination of organic carbon and microbial biomass C, N and P. Total nitrogen and phosphorus in manures / composts – Ammoniacal and nitrate nitrogen – Water soluble P_2O_5, potassium, calcium, sulphur and zinc contents of fertilizers, Adulteration in fertilizer.

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4.	**SCHEM -221**	**SOIL SURVEY, LAND USE PLANNING AND REMOTE SENSING**	**2 (1+1)**

1. SYLLABUS

A. THEORY

Soil profile development, soil survey: Significance and purpose of soil survey, methods of soil survey mapping. Types of soil surveys: Detailed, Reconnaissance, and Detailed – reconnaissance soil survey, Land use planning: Land capability classification, Soil mapping units, Soil survey interpretations and soil survey report. Major soil groups of India with special reference to Rajasthan. Soil taxonomy – a comprehensive US system of soil classification. Remote sensing: concept of remote sensing, Aerial photography, Aerial and satellite sensor imaginary, image processing and interpretations.

B. PRACTICAL

Examinations and description of typical soil profile. Interpretation of topographic map and delineation of physiographic boundaries based on important characters, typifying pedon excavation, examination and classification, interpretation of the identified soil characteristics and their evaluation for land use planning. Preparation of the soil survey report, interpretation of remote sensing information.

SOIL SCIENCE

Course Structure – at a Glance

M. Sc. (Ag.) **I Semester**		
Code No.	Title	Credits
SCHEM 511*	SOIL CHEMISTRY	2+1
SCHEM 512*	SOIL FERTILITY AND FERTILIZER USE	3+1
SCHEM 513*	SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY	2+1
SCHEM 514	RADIO ISOTOPES IN SOIL AND PLANT ANALYSIS	2+1
II Semester		
SCHEM 521*	SOIL BIOLOGY AND BIOCHEMISTRY	2+1
SCHEM 522	SOIL, WATER AND AIR POLLUTION	2+1
SCHEM 523	REMOTE SENSING AND GIS TECHNIQUES FOR SOIL AND CROP STUDIES	2+1
SCHEM 524	GEOMORPHOLOGY AND GEOCHEMISTRY	2+0
SCHEM 525	SOIL EROSION AND CONSERVATION	2+1
PGS507 NC	INTEGRAL AND DIFFERENTIAL CALCULUS (Pre-requisite for Soil Physics)	3+0
III Semester		
SCHEM 531	SOIL PHYSICS	2+1
SCHEM 532	MANAGEMENT OF PROBLEMATIC SOIL AND WATERS	2+1
SCHEM 533	ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS	0+2
SCHEM 534	FERTILIZER TECHNOLOGY	1+0
SCHEM 535	SYSTEM APPROACHES IN SOIL AND CROP STUDIES	2+1
SCHEM 536	LAND DEGRADATION AND RESTORATION	1+0
SCHEM 541	COMPREHENSIVE EXAMINATION (NC)	
SCHEM 591	MASTER'S SEMINAR	1+0
SCHEM 599	MASTER'S RESEARCH	20
Ph. D. **I Semester**		
SCHEM 611*	ADVANCES IN SOIL FERTILITY	2+1
SCHEM 612*	ADVANCES IN SOIL PHYSICS	2+0
SCHEM 613	PHYSICAL CHEMISTRY OF SOILS	2+0
II Semester		
SCHEM 621	SOIL GENESIS AND MICROPEDOLOGY	2+1

SCHEM 622	BIOCHEMISTRY OF SOIL ORGANIC MATTER	2+1
SCHEM 623	LAND USE PLANNING AND WATERSHED MANAGEMENT	2+0
SCHEM 641	PRELIMINARY -ORAL & WRITTEN (NC)	
SCHEM 691	DOCTORAL SEMINAR I	1+0
SCHEM 692	DOCTORAL SEMINAR II	1+0
SCHEM 699	DOCTORAL RESEARCH	45

***Core courses**.

SOIL SCIENCE
Course Contents

SCHEM 511 SOIL CHEMISTRY 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.

Theory
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; soil organic matter - fractionation of soil organic matter and different fractions, 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,

clay-membrane electrodes and ionic activity measurement, thermodynamics, statistical mechanics; anion and ligand exchange - innersphere 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, ECe, 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, Eh by the use of Eh-pH meter and conductivity meter
- Determination of organic matter fractions – HA, FA, Lignin & humus
- Adsorption-desorption of phosphate/sulphate by soil using simple adsorption isotherm
- Determination of titratable acidity of an acid soil by BaCl2-TEA method
- Determination of lime requirement of an acid soil by buffer method
- Determination of gypsum requirement of an alkali soil

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford and IBH.

Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.

Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.

Greenland DJ & Hayes MHB. *Chemistry of Soil Constituents*. John Wiley

& Sons.
McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.
Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ. Press.
Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.
Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.
Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley & Sons.
Van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SCHEM 512 SOIL FERTILITY AND FERTILIZER USE 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.

UNIT X

Principles and application of colorimeter, Flame-photometry and atomic absorption spectroscopy

Practical

- Chemical analysis of soil for total and available nutrients (Total and available N, P, K, Cu, Mn, Zn, Fe and S)
- Analysis of plants for essential elements (N, P, K, Cu, Mn, Zn, Fe and S)

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Kabata-Pendias A & Pendias H. 1992. *Trace Elements in Soils and Plants*. CRC Press.

Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technology*. Scientific Publ.

Leigh JG. 2002. *Nitrogen Fixation at the Millennium*. Elsevier.

Mengel K & Kirkby EA. 1982. *Principles of Plant Nutrition*. International Potash Institute, Switzerland.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.
Pierzinsky GM, Sims TJ & Vance JF. 2002. *Soils and Environmental Quality.* 2nd Ed. CRC Press.
Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients*. John Wiley & Sons.
Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* 5th Ed. Prentice Hall of India.
Troeh FR & Thompson LM. 2005. *Soils and Soil Fertility*. Blackwell.

SCHEM 513 SOIL MINERALOGY, GENESIS, CLASSIFICATION AND SURVEY

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

Factors of soil formation, soil forming processes;
weathering of rocks and mineral transformations; soil profile; weathering sequences of minerals with special reference to Indian soils.

UNIT IV

Concept of soil individual; soil classification systems - historical developments and modern systems of soil classification with special

emphasis on soil taxonomy; soil classification, soil mineralogy and soil maps – usefulness.

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, thematic soil maps, cartography, mapping units, techniques for generation of soil maps.

UNIT VI

Landform – soil relationship; major soil groups of India with special reference to respective states; land capability classification and land 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

- 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 for preparation of base maps and thematic maps, processing of field sheets, compilation and obstruction of maps in different scales
- Land use planning exercises using conventional and RS tools

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Buol EW, Hole ED, MacCracken RJ & Southard RJ. 1997. *Soil Genesis and Classification*. 4th Ed. Panima Publ.

Dixon JB & Weed SB. 1989. *Minerals in Soil Environments*. 2nd Ed. Soil Science Society of America, Madison.

Grim RE. 1968. *Clay Mineralogy*. McGraw Hill.
Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
Sehgal J. 2002. *Introductory Pedology: Concepts and Applications*. New Delhi
Sehgal J. 2002. *Pedology - Concepts and Applications*. Kalyani.
USDA. 1999. *Soil Taxonomy*. Hand Book No**.** 436. 2nd Ed. USDA NRCS, Washington.
Wade FA & Mattox RB. 1960. *Elements of Crystallography and Mineralogy*. Oxford & IBH.
Wilding LP & Smeck NE. 1983. *Pedogenesis and Soil Taxonomy*: II. *The Soil Orders*. Elsevier.
Wilding NE & Holl GF. (Eds.). 1983. *Pedogenesis and Soil Taxonomy*. I. *Concept and Interaction*. Elsevier.

SCHEM 514 RADIOISOTOPES IN SOIL AND PLANT STUDIES 2+1

Objective

To train students in the use of radioisotopes in soil and plant research

Theory

UNIT I

Atomic structure, radioactivity and units; radioisotopes - properties and decay principles; nature and properties of nuclear radiations; interaction of nuclear radiations with matter

UNIT II

Principles and use of radiation monitoring instruments - proportional, Geiger Muller counter, solid and liquid scintillation counters; neutron moisture meter, mass spectrometry, auto radiography

UNIT III

Isotopic dilution techniques used in soil and plant research; use of stable isotopes; application of isotopes in studies on organic matter, nutrient transformations, ion transport, rooting pattern and fertilizer use efficiency; carbon dating

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 32P/ 65Zn
- Use of neutron probe for moisture determination
- Sample preparation and measurement of 15N enrichment by mass spectrophotometery/ emission spectrometry

Suggested Readings

Comer CL. 1955. *Radioisotopes in Biology and Agriculture: Principles and Practice*. Tata McGraw Hill.

Glasstone S. 1967. *Source Book on Atomic Energy*. East West Press.

Michael FL & Annunziata. 2003. *Handbook of Radioactivity Analysis*. Academic Press.

SCHEM 521 SOIL BIOLOGY AND BIOCHEMISTRY 2+1

Objective

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

Theory

UNIT I

Soil biota, soil microbial ecology, types of organisms in different soils; soil microbial biomass; microbial interactions; un-culturable soil biota.

UNIT II

Microbiology and biochemistry of root-soil interface; phyllosphere and rhizosphere; 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, humus formation; cycles of important organic nutrients.

UNIT IV

Biodegradation of organic wastes and their use for production of biogas and manures; biotic factors in soil development; microbial toxins in the soil.

UNIT V

Preparation and preservation 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. BIS standards for quality control.

Practical

- Determination of soil microbial population
- Soil microbial biomass (C, N and P)
- Fractionation of organic matter and functional groups
- Soil enzymes
- Measurement of soil microbial processes such as nitrification, N2 fixation, S oxidation, P solubilization

Suggested Readings

Alexander M. 1977. *Introduction to Soil Microbiology*. John Wiley & Sons.

Burges A & Raw F. 1967. *Soil Biology*. Academic Press.

McLaren AD & Peterson GH. 1967. *Soil Biochemistry*. Vol. XI. Marcel Dekker.

Metting FB. 1993. *Soil Microbial Ecology – Applications in Agricultural and Environmental Management*. Marcel Dekker.

Paul EA & Ladd JN. 1981. *Soil Biochemistry*. Marcel Dekker.

Reddy MV. (Ed.). *Soil Organisms and Litter in the Tropics*. Oxford & IBH.

Russel RS. 1977. *Plant Root System: Their Functions and Interaction with the Soil*. ELBS & McGraw Hill.

Stotzky G & Bollag JM. 1993. *Soil Biochemistry.* Vol. VIII. Marcel Dekker.

Sylvia DN. 2005. *Principles and Applications of Soil Microbiology*. Pearson Edu.
Wild A. 1993. *Soil and the Environment - An Introduction*. Cambridge Univ. Press.

SCHEM 522 SOIL, WATER AND AIR POLLUTION 2+1

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Objective

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

Theory

UNIT I

Soil, water and air pollution problems associated with agriculture, nature and extent.

UNIT II

Nature and sources of pollutants – agricultural, industrial, urban wastes, fertilizers and pesticides, acid rains, oil spills etc.; air, water and soil pollutants - their CPC standards and effect on plants, animals and human beings.

UNIT III

Sewage and industrial effluents – their composition and effect on soil properties/health, and plant growth and human beings; soil as sink for waste disposal.

UNIT IV

Pesticides – their classification, behavior in soil and effect on soil microorganisms.

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 in contaminated soils and plants
- Management of contaminants in soil and plants to safeguard food safety

Suggested Readings

Lal R, Kimble J, Levine E & Stewart BA. 1995. *Soil Management and Greenhouse Effect.* CRC Press.

Middlebrooks EJ. 1979. *Industrial Pollution Control*. Vol. I. *Agro-Industries*. John Wiley Interscience.

Ross SM. *Toxic Metals in Soil Plant Systems*. John Wiley & Sons.

Vesilund PA & Pierce 1983. *Environmental Pollution and Control*. Ann Arbor Science Publ.

SCHEM 523 REMOTE SENSING AND GIS TECHNIQUES FOR SOIL, WATER AND CROP STUDIES 2+1

Objective

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

Theory

UNIT I

Introduction and history of remote sensing; sources, propagation of radiations in atmosphere; interactions with matter.

UNIT II

Sensor systems - camera, 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.

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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 geostatistical 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

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Edu.

Elangovan K. 2006. *GIS Fundamentals, Applications and Implementations*. New India Publ. Agency.

Lillesand TM & Kiefer RW. 1994. *Remote Sensing and Image Interpretation*. 3rd Ed. Wiley.

Nielsen DR & Wendroth O. 2003. *Spatial and Temporal Statis*tics. Catena Verloggmbh.

Star J & Esles J. 1990. *Geographic Information System: An Introduction*. Prentice Hall.

SCHEM 524 GEOMORPHOLOGY AND GEOCHEMISTRY 2+0

Objective

To impart knowledge about the landforms, physiography and morphology of the earth surface, and distribution and weathering elements in the earth crust.

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 and trace elements.

Suggested Readings

Brikland PW. 1999. *Soils and Geomorophology*. 3rd Ed. Oxford Univ. Press.

Likens GE & Bormann FH. 1995. *Geochemistry*. 2nd Ed. Springer Verlag.

Mortvedt JJ, Shuman LM, Cox FR & Welch RM. 1991. *Micronutrients in Agriculture*. 2nd Ed. SSSA, Madison.

SCHEM 525 SOIL EROSION AND CONSERVATION 2+1

Objective

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

Theory

UNIT I

History, distribution, identification and description of soil erosion problems in India.

UNIT II

Forms of soil erosion; effects of soil erosion and factors affecting soil erosion; types and mechanisms of water erosion; raindrops and soil erosion; rainfall erosivity - estimation as 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; socioeconomic aspects of watershed management; case studies in respect to monitoring and evaluation of watersheds; use of remote sensing in assessment and planning of watersheds.

Practical

- Determination of different soil erodibility indices - suspension percentage, dispersion ratio, erosion ratio, clay ratio, clay/moisture equivalent ratio, 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

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.) 1996. *Soil Management in Relation to Land Degradation and Environment*. Bull. Indian Society of Soil Science No. 17.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Spl Publ. No. 49, Madison, USA.

Gurmal Singh, Venkataramanan C, Sastry G & Joshi BP. 1990. *Manual of Soil and Water Conservation Practices*. Oxford & IBH.
Hudson N. 1995. *Soil Conservation*. Iowa State Univ. Press.
Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
Oswal MC. 1994. *Soil Physics*. Oxford & IBH.

SCHEM 531 SOIL PHYSICS 2+1

Objective

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

Theory

UNIT I

Scope of soil physics and its relation with other branches of soil science; soil as a three phase system.

UNIT II

Soil texture, textural classes, mechanical analysis, specific surface.

UNIT III

Soil consistence; dispersion and workability of soil; 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 (Gravemetric & Moisture meter)
- Measurement of soil-water potential by using tensiometer and gypsum blocks
- Determination of hydraulic conductivity under saturated and unsaturated conditions
- Determination of infiltration rate of soil
- Determination of bulk density by core sampler methods
- Soil temperature measurements.
- Estimation of water balance components in bare and cropped fields.

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Ghildyal BP & Tripathi RP. 2001. *Soil Physics*. New Age International.

Hanks JR & Ashcroft GL. 1980. *Applied Soil Physics*. Springer Verlag.

Hillel D. 1972. *Optimizing the Soil Physical Environment toward Greater Crop Yields*. Academic Press.

Hillel D. 1980. *Applications of Soil Physics*. Academic Press.

Hillel D. 1980. *Fundamentals of Soil Physics*. Academic Press.

Hillel D. 1998. *Environmental Soil Physic*s. Academic Press.

Hillel D. 2003. *Introduction to Environmental Soil Physics*. Academic Press.
Indian Society of Soil Science. 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley-Interscience.
Kohnke H. 1968. *Soil Physics*. McGraw Hill.
Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
Oswal MC. 1994. *Soil Physics*. Oxford & IBH.
Saha AK. 2004. *Text Book of Soil Physics*. Kalyani.

SCHEM 532 MANAGEMENT OF PROBLEM SOILS AND WATERS 2+1

Objective

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

Theory

UNIT I
Area and distribution of problem soils – acidic, saline, sodic and physically degraded soils; origin and basic concept 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; salt balance under irrigation; characterization of brackish waters, area and extent; relationship in water use and quality.

UNIT VI

Agronomic practices in relation to problematic soils; cropping pattern for utilizing poor quality ground waters.

Practical

- Characterization of acid, acid sulfate, salt-affected and calcareous soils
- Determination of cations (Na^{+}, K^{+}, Ca^{++} and Mg^{++}) in ground water and soil samples
- Determination of anions (Cl^{-}, $SO4^{--}$, $CO3^{--}$ and $HCO3^{-}$) in ground waters and soil samples
- Lime and gypsum requirements of acid and sodic soils

Suggested Readings

Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.

Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.

USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.

SCHEM 533 ANALYTICAL TECHNIQUES AND INSTRUMENTAL METHODS IN SOIL AND PLANT ANALYSIS 0+2

Objective

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

Practical

UNIT I

Preparation of solutions for standard curves, analytical reagents, qualitative reagents, indicators and standard solutions for acid-base, oxidationreduction and complexometric titration; soil, water and plant sampling

techniques, their processing and handling.

UNIT II

Determination of nutrient potentials and potential buffering capacities of soils for phosphorus and potassium; estimation of phosphorus, ammonium and potassium fixation capacities of soils.

UNIT III

Principles of visible, ultraviolet and infrared spectrophotometery, atomic absorption, flame-photometry, inductively coupled plasma spectrometry; chromatographic techniques, mass spectrometry and X-ray defractrometery; identification of minerals by X-ray by different methods.

UNIT IV

Electrochemical titration of clays; determination of cation and anion exchange capacities of soils; estimation of exchangeable cations (Na, Ca, Mg, K); estimation of root cation exchange capacity.

UNIT V

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.

Suggested Readings

Hesse P. 971. *Textbook of Soil Chemical Analysis*. William Clowes & Sons.

Jackson ML. 1967. *Soil Chemical Analysis*. Prentice Hall of India.

Keith A Smith 1991. *Soil Analysis; Modern Instrumental Techniques*. Marcel Dekker.

Kenneth Helrich 1990. *Official Methods of Analysis*. Association of Official Analytical Chemists.

Page AL, Miller RH & Keeney DR. 1982. *Methods of Soil Analysis*. Part II. SSSA, Madison.

Piper CE. *Soil and Plant Analysis*. Hans Publ.

Singh D, Chhonkar PK & Pandey RN. 1999. *Soil Plant Water Analysis - A Methods Manual*. IARI, New Delhi.

Tan KH. 2003. *Soil Sampling, Preparation and Analysis*. CRC Press/Taylor & Francis.

Tandon HLS. 1993. *Methods of Analysis of Soils, Fertilizers and Wat*ers. FDCO, New Delhi.

Vogel AL. 1979. *A Textbook of Quantitative Inorganic Analysis*. ELBS

Longman.

SCHEM 534 FERTILIZER TECHNOLOGY 1+0

Objective

To impart knowledge about how different fertilizers are manufactured using different kinds of raw materials and handling of fertilizers and manures.

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.

Suggested Readings

Brady NC & Weil RR. 2002. *The Nature and Properties of Soils.* Pearson Edu.

Fertilizer (Control) Order, 1985 and the Essential Commodities Act. FAI New Delhi.

Kanwar JS. (Ed.). 1976. *Soil Fertility: Theory and Practice*. ICAR.

Olson RA, Army TS, Hanway JJ & Kilmer VJ. 1971. *Fertilizer Technology and Use.* 2nd Ed. Soil Sci. Soc. Am. Madison.

Prasad R & Power JF. *Soil Fertility Management for Sustainable*

Agriculture. CRC Press.
Tisdale SL, Nelson SL, Beaton JD & Havlin JL. 1999. *Soil Fertility and Fertilizers.* McMillan Publ.Vogel AI. 1979. *Textbook of Quantitative Inorganic Analysis*. ELBS.

SCHEM 535 SYSTEM APPROACHES IN SOIL AND CROP STUDIES 2+1

Objective

To train the students in concepts, methodology, technology and use of systems simulation in soil and crops studies.

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

Suggested Readings

Benbi DK & Nieder R. (Eds.). 2003. *Handbook of Processes and Modelling in the Soil - Plant System*. Haworth Press.
Hanks J & Ritchie JT. (Eds.). 1991. *Modelling Plant and Soil System. Agronomy***.** Bull. No 31. Soil Sci. Society of America, Madison.
Rajaraman V. 2004. *Computer Programming in Fortran 90 and 95*. PHI.
Tsuji GY, Gerrit H & Philip T. 1998. *Understanding Options for Agricultural Production.* Kluwer.
von Bertalanffy Ludwig 1969. *General Systems Theory: Foundation Development and Application*. Revised Ed. George Braziller. Reprint 1998.

Web sites

1. Documentation of the respective models. (http://www.simulistics.com/ for Simile; http://www.iseesystems.com for Stella; and http://www.vensim.com/software.html for vensim PLE)
2. http://www.icasa.net/dssat/index.html for DSSAT; http://www.brc.tamus.edu/epic/ for EPIC
3. http://www.nrel.colostate.edu/projects/century/ for Century
4. http://www.alterra.wur.nl/NL/for WOFOST
5. http://www.apsru.gov.au/ apsru/Default.htm for APSIM
6. http://eco.wiz.uni-kassel.de/ecobas.html online Register of ecological models
7. Plentinger MC Penning de Vries FWT, Editors (1996) CAMASE Register of Agro-ecosystems Models. DLO-Research Institute for Agrobiology and Soil Fertility (AB-DLO)
8. Agricultural Systems – Elsevier at http://www.elsevier.com/wps/product/cws_home /405851
9. Ecological Modeling – Elsevier at http://www.elsevier.com/locate/ecolmodel

SCHEM 536 LAND DEGRADATION AND RESTORATION 1+0

Objective

To impart knowledge related to various factors and processes of land degradation and their restoration techniques.

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.

Suggested Readings

Biswas TD & Narayanasamy G. (Eds.). 1996. *Soil Management in Relation to Land Degradation and Environment. Bull. Indian Soc. Soil Sci.* 17, New Delhi.

Doran JW & Jones AJ. 1996. *Methods of Assessing Soil Quality*. Soil Science Society of America, Madison.

Greenland DJ & Szabolcs I. 1994. *Soil Resilience and Sustainable Land Use*. CABI.

Lal R, Blum WEH, Vailentine C & Stewart BA. 1997. *Methods for Assessment of Soil Degradation.* CRC Press.

Sehgal J & Abrol IP. 1994. *Soil Degradation in India - Status and Impact*. Oxford & IBH.

SCHEM 611 ADVANCES IN SOIL FERTILITY
2+1

Objective

To provide knowledge of modern concepts of soil fertility and nutrient use in crop production.

Theory

UNIT I

Modern concepts of nutrient availability; soil solution and plant growth; nutrient response functions and availability indices.

UNIT II

Nutrient movement in soils; nutrient absorption by plants; mechanistic approach to nutrient supply and uptake by plants; models for transformation and movement of major micronutrients in soils.

UNIT III

Chemical equilibria (including solid-solution equilbria) involving nutrient ions in soils, particularly in submerged soils.

UNIT IV

Modern concepts of fertilizer evaluation, nutrient use efficiency and nutrient budgeting.

UNIT V

Modern concepts in fertilizer application; soil fertility evaluation techniques; role of soil tests in fertilizer use recommendations; site-specific nutrient management for precision agriculture.

UNIT VI

Monitoring physical, chemical and biological changes in soils; permanent manurial trials and long-term fertilizer experiments; soil productivity under long-term intensive cropping; direct, residual and cumulative effect of fertilizer use.

Practicals

- Determination of Q/I relationship of Phosphorus.
- Determination of Q/I relationship of Potassium.
- Determination of root cation exchange capacity of cereals and legumes.
- Study of mobility of nutrient P and metallic cations in soil column.

• Incubation studies on the solubilization of rock phosphate using chemical and biological agents.
• Determination of phosphate potential in soil.

Suggested Readings

Barber SA. 1995. *Soil Nutrient Bioavailability*. John Wiley & Sons.
Barker V Allen & Pilbeam David J. 2007. *Handbook of Plant Nutrition*. CRC / Taylor & Francis.
Brady NC & Weil RR. 2002. *The Nature and Properties of Soils*. 13th Ed. Pearson Educ.
Cooke GW. 1979. *The Control of Soil Fertility*. Crossby Lockwood & Sons.
Epstein E. 1987. *Mineral Nutrition of Plants - Principles and Perspectives*. International Potash Institute, Switzerland.
Kabata- Pendias Alina 2001. *Trace Elements in Soils and Plants*. CRC / Taylor & Francis.
Kannaiyan S, Kumar K & Govindarajan K. 2004. *Biofertilizers Technolo*gy. Scientific Publ.
Mortvedt JJ, Shuman LM, Cox FR & Welch RM. (Eds.). 1991. *Micronutrients in Agriculture.* 2nd Ed. Soil Science Society of America, Madison.
Prasad R & Power JF. 1997. *Soil Fertility Management for Sustainable Agriculture*. CRC Press.
Stevenson FJ & Cole MA. 1999. *Cycles of Soil: Carbon, Nitrogen, Phosphorus, Sulphur, Micronutrients.* John Wiley & Sons.
Stevenson FJ. (Ed.). 1982. *Nitrogen in Agricultural Soils*. Soil Science Society of America, Madison.
Tisdale SL, Nelson WL, Beaton JD & Havlin JL. 1990. *Soil Fertility and Fertilizers.* 5th Ed. Macmillan Publ.
Wild A. (Ed.). 1988. *Russell's Soil Conditions and Plant Growth*. 11th Ed. Longman.

SCHEM 612 ADVANCES IN SOIL PHYSICS 2+0

Objective

To provide knowledge of modern concepts in soil physics.

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.

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.

Suggested Readings

Baver LD, Gardner WH & Gardner WR. 1972. *Soil Physics*. John Wiley & Sons.

Hanks and Ascheroft. 1980. *Applied Soil Physics*. Springer Verlag.
Hillel D. 1980. *Applications of Soil Physics*. Academic Press.
Hillel D. 1980. *Environmental Soil Physic*s. Academic Press.
Indian Society of Soil Science 2002. *Fundamentals of Soil Science*. ISSS, New Delhi.
Kirkham D & Powers WL. 1972. *Advanced Soil Physics*. Wiley Interscience.
Lal R & Shukla MK. 2004. *Principles of Soil Physics*. Marcel Dekker.
Oswal MC.1994. *Soil Physics*. Oxford & IBH.

SCHEM 613 PHYSICAL CHEMISTRY OF SOILS 2+0

Objective

To impart knowledge about modern concepts of physical chemistry of soils and clays, with emphasis on understanding the processes involved with practical significance.

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

Thermodynamics of nutrient transformations in soils; cationic and anionic exchange and their models, molecular interaction.

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).

Suggested Readings

Bear RE. 1964. *Chemistry of the Soil.* Oxford & IBH.
Bolt GH & Bruggenwert MGM. 1978. *Soil Chemistry*. Elsevier.
Fried M & Broeshart H. 1967. *Soil Plant System in Relation to Inorganic Nutrition.* Academic Press.
Greenland DJ & Hayes MHB. 1981. *Chemistry of Soil Processes*. John Wiley & Sons.
Greenland DJ & Hayes MHB. 1978. *Chemistry of Soil Constituents*. John Wiley & Sons.
Jurinak JJ. 1978. *Chemistry of Aquatic Systems*. Dept. of Soil Science & Biometeorology, Utah State Univ.
McBride MB. 1994. *Environmental Chemistry of Soils.* Oxford Univ. Press.
Sparks DL. 1999. *Soil Physical Chemistry*. 2nd Ed. CRC Press.
Sposito G. 1981. *The Thermodynamics of Soil Solutions*. Oxford Univ.Press.
Sposito G. 1984. *The Surface Chemistry of Soils*. Oxford Univ. Press.
Sposito G. 1989. *The Chemistry of Soils*. Oxford Univ. Press.
Stevenson FJ. 1994. *Humus Chemistry*. 2nd Ed. John Wiley.
van Olphan H. 1977. *Introduction to Clay Colloid Chemistry*. John Wiley & Sons.

SCHEM 621 SOIL GENESIS AND MICROPEDOLOGY
2+1

Objective

To impart knowledge about the pedogenic processes in soils and to acquaint with the micro-pedological study of soil profile.

Theory

UNIT I

Pedogenic evolution of soils; soil composition and characterization.

UNIT II

Weathering and soil formation – factors and pedogenic processes; stability and weathering sequences of minerals.

UNIT III

Assessment of soil profile development by mineralogical and chemical analysis.

UNIT IV

Micro-pedological features of soils – their structure, fabric analysis, role in genesis and classification.

Practicals:

- Total elemental analysis of soil
- Separation and elemental analysis of clay
- Determination of weathering indices

Suggested Readings

Boul SW, Hole ED, MacCraken RJ & Southard RJ. 1997. *Soil Genesis and Classification.* 4th Ed. Panima Publ.

Brewer R. 1976. *Fabric and Mineral Analysis of Soils.* John Wiley & Sons.

SCHEM 622 BIOCHEMISTRY OF SOIL ORGANIC MATTER 2+1

Objective

To impart knowledge related to chemistry and reactions of organic substances and their significance in soils.

Theory

UNIT I

Organic matter pools in soil; composition and distribution of organic matter in soil and its functions; environmental significance of humic substances; decomposition of organic residues in soil in relation to organic matter pools.

UNIT II

Biochemistry of the humus formation; different pathways for humus synthesis in soil; soil carbohydrates and lipids.

UNIT III

Nutrient transformation – N, P, S; trace metal interaction with humic substances, significance of chelation reactions in soils.

UNIT IV

Reactive functional groups of humic substances, adsorption of organic compounds by clay and role of organic substances in pedogenic soil aggregation processes; clay-organic matter complexes.

UNIT V

Humus - pesticide interactions in soil, mechanisms.

Practicals:

• Determination of soil organic carbon by dry combustion and colorimetric methods
• Fractions of soil organic matter
• Estimation of hymatomelanic, humic acid, ß humus and fulvic acid
• Determination of CEC and functional group of humic substances
• Elemental composition of organic matter

Suggested Readings

Beck AJ, Jones KC, Hayes MHB & Mingelgrin U. 1993. Organic *Substances in Soil and Water: Natural Constituents and their Influences on Contaminant Behavior*. Royal Society of Chemistry, London.

Gieseking JE. 1975. *Soil Components*. Vol. 1. *Organic Components*. Springer-Verlag.

Kristiansen P, Taji A & Reganold J. 2006. *Organic Agriculture: A Global Perspective.* CSIRO Publ.

Magdoff F & Weil RR 2004. *Soil Organic Matter in Sustainable Agriculture*. CRC Press.

Mercky R & Mulongoy K. 1991. *Soil Organic Matter Dynamics and Sustainability of Tropical Agriculture.* John Wiley & Sons.

Paul EA. 1996. *Soil Microbiology and Biochemistry*. Academic Press.

Stevenson FJ. 1994. *Humus Chemistry – Genesis, Composition and Reactions.* John Wiley & Sons.

SCHEM 623 LAND USE PLANNING AND WATERSHED MANAGEMENT

2+0

Objective

To teach the better utilization of land for agricultural purposes, and better management of run-off or surplus/excessive rain-water in the catchment area for agricultural purposes in a watershed.

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.

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.

Suggested Readings

All India Soil and Land Use Survey Organisation 1970. *Soil Survey Manual*. IARI, New Delhi.

FAO. 1976. *A Framework for Land Evaluation*, Handbook 32. FAO.

Sehgal JL, Mandal DK, Mandal C & Vadivelu S. 1990. *Agro-Ecological Regions of India*. NBSS & LUP, Nagpur.

Soil Survey Staff 1998. *Keys to Soil Taxonomy*. 8th Ed. USDA & NRCS, Washington, DC.

USDA 1974. *A Manual on Conservation of Soil and Water Handbook of Professional Agricultural Workers*. Oxford & IBH.

SOIL SCIENCE
List of Journals

1. Advances in Agronomy
2. Annals of Arid Zone
3. Australian Journal of Agricultural Research
4. Australian Journal of Soil Research
5. Biology and Fertility of Soils
6. Communications in Soil Science and Plant Analysis
7. Clays and Clay minerals
8. European Journal of Soil Science
9. Geoderma
10. Indian Journal of Agricultural Sciences
11. Journal of Plant Nutrition and Soil Science
12. Journal of the Indian Society of Soil Science
13. Nutrient Cycling in Agroecosystems
14. Plant and Soil
15. Soil and Tillage Research
16. Soil Biology and Biochemistry
17. Soil Science
18. Soil Science Society of America Journal
19. Soil Use and Management
20. Water, Air and Soil Pollution
21. Water Resources Research

Suggested Broad Topics for Master's and Doctoral Research

• Degradation and restoration of soil as natural resource
• Biochemistry of processes at the soil-root interface
• Impact of current agricultural practices and agrochemicals on soil quality/biodiversity
• Integrated nutrient management for sustainable agriculture
• Fertilizer use efficiency in different soil conditions/cropping systems
• Use of remote sensing and GIS as diagnostic tool for natural resource management
• Role of biological agents in soil productivity

- Modeling solute (salt, fertilizer, pesticides) transport in soil
- Use of poor quality waters in Agriculture
- Soil testing and crop response
- Site-specific nutrient management and precision agriculture
- Nutrient dynamics in soil-plant system and modeling nutrient uptake
- Tillage and crop residue management in crop production
- Utilization of urban and industrial wastes/effluents in Agriculture
- Management of problematic soils
- Impact of climate change on soil processes
- Micronutrients in soil, plant and human health
- Water management strategies in different cropping systems
- Simulation models for growth and production of different crops
- Varietals response to soil salinity/ sodicity/ nutrients/ pollutants, etc
- Soil and water pollution - monitoring and control
- Genesis, formation and classification of soils
- Soil conservation, preservation and management for sustainable agriculture
- Remediation of polluted and contaminated soils

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PGS 521 (NC) Integral and Differential Calculus 3+0

Meanings of a derivate, Derivatives of algebric functions, derivates of Trigonometric functions. Derivation of inverse Trigonometric functions. Differentiation of log x, a^x, e^x, differentiation of products and quotient, functions, Logarithmic differentiation, Differentiation of implicit functions, Successive differentiation; Maxima and Minima, Meanings of Integration, Integrals of sone functions: Define integral ux + substitution method, integral of a linear factor raised to any power; Integration by parts, Integration of e^{ax} Sin X and e^{ax}. Cos X, Integration of trignometric functions; Differntial equations: (i) Equation in which the variable are separable Mdx + May = 0 (ii) Auxillary equations having roots equal.

Minor and supporting course for PG (M. Sc. / Ph. D.) students of Department of Agricultural Chemistry and Soil Science, RCA, Udaipur.

A PG student of Soil Science has to take 9 credit hours courses as minor / supporting in any of the following discipline:

1. Agronomy
2. Plant Physiology
3. Horticulture
4. Statistics
5. Bio-Chemistry

Department of Agricultural Statistics & Computer Application
UG COURSES

STAT-311/321	Industrial Statistics (Common Course for DT & FT Streams)	2(1+1)
STAT - 312/322	Statistics for Home Science	3(2+1)
STAT - 411	Statistics For Engineers- I	3(2+1)
COMP -121	Introduction to Computer Applications	2(1+1)
STAT - 321	Statistics	2(1+1)

PG COURSES
(Effective from Academic Year 2009-10)

SEMESTER – I

Course No.	Course Title	Cr. Hrs
STAT-511	Statistical Methods	3(2+1)
	(Common for Ag., H.Sc. and Fisheries faculties)	
STAT-512	Statistical Methods In Engineering	3(2+1)
STAT-611	Sample Surveys	3(2+1)
STAT-612	Computer Applications In Agriculture	3(2+1)
STAT-613	Statistical Methods in Bioassay and Probit Analysis	3(2+1)

SEMESTER – II

STAT-501	Elementary Statistics (Non credit for Home Science)	3(2+1)
STAT-521	Design of Experiments - I	3(2+1)
STAT-522	Economic Statistics	3(2+1)
STAT-523	Non-Parametric Statistics	3(2+1)
STAT-621	Research Methodology	3(2+1)
STAT-622	Design of Experiments - II	3(2+1)
STAT-623	Econometrics	3(3+0)
STAT-624	Psychometrics	3(3+0)

COURSE NO. STAT - 311/321	**INDUSTRIAL STATISTICS (Common Course for DT & FT Streams)**	**Cr.Hrs. 2(1+1)**

Theory:

Definition and scope of Statistics, Measures of central tendency, Measures of dispersion, Moments, Skewness and Kurtosis, Elementary notions of probability, Laws of addition and multiplication probability, Binomial, Poisson and Normal distributions and their applications, Introduction to testing of hypotheses and tests of significance, 'Z' and 't' test for one and two sample problems, 'Chi - square' test for independence of attributes and goodness of fit, Simple Correlation coefficient and its test of significance, Simple Linear regression.

Practicals:

Measures of central tendency, Measures of dispersion, Application of 'Z' test for one and two sample problems, Application of 't' test for one and two sample problems, Application of Chi –Square test, Simple Correlation and regression.

Suggested Readings:

1. Snedecor and Cochran (1967). Statistical Methods. Oxford and IBH Publishing Co., New Delhi.
2. **V.K. Kapoor (2005). Fundamentals of Statistics for Business and Economics. Sultan Chand and Sons, New Delhi.**
3 **S.C. Gupta and V.K. Kapoor (2006). Fundamentals of Statistics. Himalaya Publishing House, New Delhi.**

COURSE NO. STAT - 312/322 **STATISTICS FOR HOME SCIENCE** **Cr.Hrs. 3(2+1)**

Theory:

Importance of Statistics in Home Science, Measures of Central Tendency: Mean, Median, Mode, Geometric mean, Harmonic mean and Weighted Mean. Measures of Dispersion: Range, Mean Deviation, Standard Deviation, Inter-Quartile Deviation, Standard error, Coefficient of Variation. Tests of Significance: Z- test for one and two sample problems, Students t-test for one and two sample problems, Paired t-test. Chi-square test: Association of attributes (2x2 & rxs contingency table) and goodness of fit.
Simple Linear Regression, Simple Correlation, rank correlation, test of significance of correlation and regression coefficients. Analysis of variance for one way and two way classification.

Practicals :

Computation of A.M., Median and Mode for raw data and frequency distribution. Computation of S.D. and C.V. for raw data and frequency distribution, Z- test for one and two sample problems, t-test for one and two sample problems, Paired t-test. Chi-square test for testing independence of attributes in 2x2 & rxs contingency table and goodness of fit. Computation of simple correlation coefficient. Computation of rank correlation coefficient .Estimation of Simple Regression lines. Analysis of Variance for one way and two way classification .

Suggested Readings:

1. S.R.S. Chandel (2003). Hand Book of Agricultural Statistics. Achal Prakashan Mandir, Kanpur.
2. G.N. Rao (2007). Statistics for Agricultural Sciences. Oxford and IBH Delhi.
3. S.C. Gupta (2006). Fundamentals of Statistics. Himalaya Publishing House, New Delhi.

COURSE NO. STAT - 411 STATISTICS FOR ENGINEERS-I
Cr.Hrs.3 (2+1)

Theory

UNIT-I: Random variable, mathematical expectation, moment generating function, probability distribution; Binomial, Poisson's and Normal distribution.

UNIT –II: Correlation and regression analysis: rank correlation, partial correlation, multiple correlations, fitting of multiple regressions equations.

UNIT -III Test of significance: Null hypothesis and alternative hypothesis, type-I and type-II errors, level of significance, critical region, degree of freedom, Z-test and Students t-test for one sample and two sample problems, paired t-test, test of significance of simple, partial and multiple correlations, Chi-square test for testing independence of attributes, Yates's Correction

UNIT-IV Analysis of variance: Assumptions, general considerations in conducting experiments,
Uniformity trials, Fairfield Smith variance law, basic principles of experimental design, Completely Randomized Design, Randomized Block Design and Latin Square design with statistical analysis.

Practicals:
Simple problems based on Binomial, Poisson and Normal distributions. Correlation and regression analysis: rank correlation, partial correlation, multiple correlations, fitting of multiple regressions equations. Z-test and Students t-test for one sample and two sample problems, paired t-test, test of significance of simple and partial correlations. Chi-square test for testing independent of attributes, Yates's Correction. Analysis of Completely Randomized Design, Randomized Block Design and Latin Square Design

Suggested Readings:
1 S.C. Gupta (2006). Fundamentals of Statistics. Himalaya Publishing House, New Delhi.

2 R. Rangaswami (2006). A Text Book on Agricultural Statistics. New Age International Publishers Limited, New Delhi

3 G.W. Snedecor and W.G. Cochran (1968). Statistical Methods. Oxford and IBH, New Delhi.

4 Douglas C. Montgomery (1983). Design and Analysis of Experiments. John Wiley & Sons
New York

COURSE NO. COMP - 121 **INTRODUCTION TO COMPUTER APPLICATIONS** **Cr.Hrs. 2(1+1)**

Theory:

Introduction to Computers, Anatomy of Computers, Input and Output Devices. Units of Memory, Concept of hardware and software, Classification of Computers. Personal Computers, Booting of computer, warm and cold booting. Computer Viruses. Operating System – DOS and WINDOWS. Disk Operating System (DOS): Some fundamental DOS Commands: DIR, MD, CD, COPY, TIME, DATE. WINDOWS: GUI, Desktop and its elements, WINDOWS Explorer, working with files and folders; setting time and date, starting and shutting down of WINDOWS. Anatomy of a WINDOW. Introduction to MSWORD: Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars. Creating, Editing, Formatting and Saving a document in MSWORD; MSEXCEL: Electronic Spreadsheets, Creating, Editing and Saving a spreadsheet with MSEXCEL.

Practicals :

Study of Computer Components; Booting of Computer and its Shut Down; Practice of some fundamental DOS Commands, DIR, MD, CD, COPY, TIME, DATE, Practicing WINDOWS Operating System, WINDOWS Explorer, Creating Folders, COPY and PASTE functions; MSWORD : Use of options from Tool Bars, Format, Insert and Tools (Spelling & Grammar) Alignment of text, Creating a Table, Merging of Cells, Column and Row width; MSEXCEL: Creating a Spreadsheet, Alignment of rows, columns and cells using Format tool bar. Editing and Saving a spreadsheet with MSEXCEL.

Suggested Readings:

1. V. K. Kapoor (2005). Computers and Information Technology. Sultan Chand and
Sons, New Delhi.
2 inaitna Kaosalaa,, jayaa inaitna (2001) . kmPyaUTr iva&ana, ka^laoja bauk ha]sa, (p`a) ila caaoDa rasta, jayapur

COURSE NO. STAT 321 STATISTICS Cr.Hrs. 2(1+1)

Theory :

Introduction, Measures of Central Tendency: Characteristics of an Ideal Average, Arithmetic Mean, Median, Mode, Merits and Demerits of Arithmetic Mean. Measures of Dispersion: Standard Deviation, Variance, Coefficient of Variation and the concept of Standard Error. Tests of Significance- Types I and Type II Errors, Null Hypothesis, Level of Significance and Degrees of Freedom, Steps involved in testing of hypotheses; Large Sample Test: Z-test for one and two sample problems; Small Sample Test for Means: Student's t-test for one and two sample problems, Paired t test.; Chi-square test for testing independence of attributes in 2x2 contingency table, Yates' Correction for continuity; Correlation: Types of Correlation and identification through Scatter Diagram, Computation of Correlation Coefficient (r) and its testing. Linear Regression of Y on X and X on Y. Inter-relation between 'r' and the regression coefficients, fitting of regression equations.

Practicals :

Computation of Arithmetic 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; Z-test for one and two sample problems; Student's t-test for one and two sample problems; Paired t-test; Chi-Square test for testing the independence of attributes in 2x2 Contingency Table, Yates' Correction for continuity; Computation of Correlation Coefficient (r) and its testing; Fitting of regression equations- Y on X and X on Y;

Suggested Readings:

1. S.R.S. Chandel (2003). Hand Book of Agricultural Statistics. Achal Prakashan Mandir, Kanpur.
2. S.C. Gupta (2006). Fundamentals of Statistics. Himalaya Publishing House, New Delhi.
3. R. Rangaswami (2006). A Text Book of Agricultural Statistics. New Age International Publishers Ltd., New Delhi.

OURSE NO. STAT-511 **STATISTICAL METHODS** (Common for Ag., H.Sc. and Fisheries) **Cr.Hrs. 3(2+1)**

Theory:

Probability and Probability Distribution: Various definitions of probability, Addition and multiplication laws of probability and simple problems based on them. Expectation of a random variable, Moments, Skewness and Kurtosis.
Binomial and Poisson distribution, their fitting and simple problems based on them, Normal distribution, their properties and uses. Sampling: Sampling v/s Complete enumeration, Probability and non probability sampling, S.R.S. with and without replacement.
Test of significance: Hypothesis, null and Alternative hypothesis, type-I and type-II error, Level of significance, Critical region, one and two tailed tests, Procedure for testing of hypotheses. Standard Normal deviate test for single mean, difference of two means. Proportion, difference of proportion and confidence interval, students `t' test, for comparison involving one and two sample means, paired `t' test, Confidence interval, Chi-square test for goodness of fit and independence of two attributes (2x2 and r x s contingency table) and Yate's correction for continuity, Correlation and Regression : Simple and partial correlation coefficients, Linear and multiple regressions. Partial regression coefficients, multiple correlation coefficients and their tests of significance.
Design of Experiments : Analysis of C.R.D., R.B.D. and L.S.D. with one observation per cell.

Practicals :

Simple problem based on probability, Simple problems based on Binomial, Poisson and Normal distribution. Problem based on area tables of Normal distribution. Draw simple random-sample of size 'n' from a given population of size 'N' with and without replacement scheme and obtain the estimate of (i) population mean (ii) population variance and (iii) standard error. Standard normal deviate tests for testing (i) $\mu = \mu_0$, (ii) $\mu_1 = \mu_2$, 't'-test for testing (i) $\mu = \mu_0$, (ii) $\mu_1 = \mu_2$, Confidence interval for means, for small and large samples. Chi-square test for goodness of fit. Chi-square test for independence of two attributes, 2x2, r x s contingency table and Yates'correction . Fitting of Regression line (i) $Y = a+bX$ and test for $\beta_{yx} = 0$ (ii) $Y = a+b_1x_1 + b_2x_2$. Partial correlation coefficients and its tests of significance. Multiple correlation coefficient and its test by F-test

Suggested Readings:

1. **V.G. Panse and P.V. Sukhatme (1985). Statistical Methods for Agricultural Workers. ICAR, New Delhi.**
2. **G.W. Snedecor and W.G. Cochran (1968). Statistical Methods. Oxford and IBH. New Delhi.**
3. **S.C. Gupta and V.K. Kapoor (2006). Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi.**
4. **Sukthame and C. Ashok (1984). Sampling Theories and Surveys with Application. ICAR, New Delhi, 3rd ed.**
5. **G.N. Rao (2007). Statistics for Agricultural Science. Oxford and IBH, New Delhi.**
6. **S.C. Gupta (2006). Fundamentals of Statistics. Himalaya Publishing House. New Delhi**

COURSE NO.	Statistical Methods In Engineering	Cr.Hrs.
STAT- 512		3(2+1)

Theory:

Basic concepts, simple problems and applications of the topics such as- Probability, sample spaces, simple and compound events, mutually exclusive, equally likely and independent events, definition of probability, classical and axiomatic approach, addition and multiplication laws of probability, conditional probability. Bayes theorem and its application, Random variables, discrete and continuous, probability density function (pdf), cumulative distribution function (cdf), mathematical expectation, mean and variance of a random variable, joint pdf, cdf, marginal and conditional densities, independence of random variables.

Binomial, Poisson, Hypergeometric, Geometric, Multinomial distributions, their means and variances, Normal distribution its properties and simple problems, Lognormal, Exponential and Weibull distribution. Definitions and applications of t, F and χ^2 (Chi- square) distribution.

Statistical Inference: Estimation, confidence intervals. Testing of hypotheses regarding means and variances.

Regression and Correlation: Linear and curvilinear regression with one independent variable, linear correlation the test of significance of regression coefficient and correlation coefficient.

Practicals :

Inferences concerning means: one and two means cases, tests of significance. Inferences concerning variances: one and two variances, tests of significance. Testing of hypothesis in 2x2, and rxs contingency tables. Fitting of Binomial and Normal distributions. testing testing of correlation and regression coefficients.

Suggested Readings:

Miller Irwin and J.W. Frannd (1977). Probability and Statistics for Engineers. Prentice Hall of India Pvt. Ltd., New Delhi.

Statistics in Research (Indian ed. 1966). Bernard Ostle. Oxford and IBH Publication Co., New Delhi.

Johnsen, N.L. and Leone, F.C. John (1964). Statistics and Experimental Design In Engineering and Physical Sciences Vol. I. Wiley and Sons, New York.

S.C. Gupta and V.K. Kapoor (2006). Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi.

COURSE NO. STAT- 611 SAMPLE SURVEYS Cr.Hrs. 3(2+1)

Theory:

Basic concepts in sampling, complete enumeration v/s sampling, field of enquiry, frames suitable for various types of surveys, elementary units, sample units of different types and sizes, selection of samples, bias in selection and estimation, sampling errors of estimates and their estimation. Simple random sampling, stratified sampling, ratio and regression estimates, systematic sampling, two stage and cluster sampling, preparation of schedule and questionnaire. Methods of enquiry, elementary idea about non-sampling errors.

Practicals :

Use of random number tables and selection of random samples by different methods, Estimation of mean, variance and standard error using SRSWR., Estimation of mean, variance and standard error using SRSWOR. Its efficiency over S.R.S.W.R. Stratified sampling, allocation of sample size to different strata under different allocation procedures. Estimation of mean and variance in case of stratified sampling (Proportionate allocation) its efficiency over S.R.S.W.O.R. Neyman allocation in stratified sampling and its efficiency over S.R.S.W.O.R. Systematic sampling, estimation of mean and variance. Circular systematic sampling, estimation of mean and variance. Cluster sampling, estimation of mean and variance. Ratio method of estimation, calculation of bias. MSE and efficiency compared to S.R.S.W.O.R. Two stage sampling with equal number of units in each P.S.U.

Suggested Readings:

1. **P.V. Sukhatme, B.V. Sukhatme and C. Ashok (1984). Sampling Theory and Survey With Applications. IASRI, New Delhi.**
2. **W.G. Cochran (1953). Sampling Techniques. Asia Publishing House, New Delhi.**

3. Des Raj (1968). Sampling Theory. Tata McGraw-Hill Publishing Company, Bombay.
4. M.N. Murthy (1967). Sampling Theory and Methods. Statistical Publishing Society, Calcutta.

COURSE NO. STAT-612 COMPUTER APPLICATIONS IN STATISTICS Cr.Hrs. 3(2+1)

Theory:

Introduction to Computers, Computer Generations, Input and Output Devices. Units of Memory, Hardware, Software and Classification of Computers. Personal Computers, Operating System – WINDOWS: GUI, Desktop and its elements, WINDOWS Explorer, working with files and folders, starting and shutting down of WINDOWS. Anatomy of a WINDOW, Title Bar, Minimum, Maximum and Close Buttons, Scroll Bars, Menus and Tool Bars. Applications – MSWORD: Word, processing and units of document, features of word-processing packages. Creating, Editing, Formatting and Saving a document in MSWORD; MSEXCEL: Electronic Spreadsheets, concept, Creating, Editing and Saving a spreadsheet with MSEXCEL. MS Power Point: Features of Power Point Package.

Practicals :

Study of Computer Components; Practicing WINDOWS Operating System, 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 & Grammar) Alignment of text; MSWORD, Creating a Table, MSEXCEL: Creating a Spreadsheet, Alignment of rows, columns and cells using Format tool bar. Editing and Saving a spreadsheet with MSEXCEL. Preparation of slides using Power Point Package.

Suggested Readings:

1. V. K. Kapoor (2005). Computers and Information Technology. Sultan Chand and Sons, New Delhi.
2. Microsoft Office (2000). BPB Publications, B-14, Caunnaut Place, New Delhi.

COURSE NO. STAT- 613 STATISTICAL METHODS IN BIOASSAY Cr.Hrs. 3(2+ 1)

AND PROBIT ANALYSIS

Theory:

Role of statistical science in biology, Purpose and structure of biological assay, Nature of direct assays, Precision of estimates, Fiducial limits in a direct assay, Utility of logarithmic transformation of doses, Indirect assays for quantitative responses, Dose response regression, Scedasticity transformation of response, Parallel line assay, Slope ratio assay, Designs suitable for bio-assay, Probit, log and angular transformations for percentage response, Other methods of estimation of median effective doses, Toxic action of mixtures.

Practicals:

Direct assay for relative potency and its precision with or without covariance, Linearizing Transformation of dose response relationship Scedasticity transformation, Probit Analysis, Parallel line assays.

Suggested Readings:

1. D. J. Finney. (1978). Statistical Methods in Biological Assay. Charles Griffin and Co. London 3rd Ed.
2. M. N. Das and N.C. Giri (1986). Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi.
3. D.J. Finey (1964). Probit Analysis. University Press, Cambridge.
4. C.I. Bliss (1970). Statistics in Biology. McGraw Hill Book Co., New York.
5. G.N. Rao (2006). Statistics for Agricultural Sciences. Oxford and IBH, New Delhi.

COURSE NO. STAT- 501 **Elementary Statistics (Non credit for Home Science)** **Cr.Hrs.3(2+ 1)**

Theory:

Introduction : Classification, tabulation and Graphic representation of data, frequency distribution, measures of central tendency-mean, mode, median, geometric, harmonic and weighted mean, Measures of dispersion – Range, mean deviation standard deviation inter-quartile deviation standard error.

Coefficient of variation. Test of significance- standard normal deviate test, Student's t- test, Chi-square test.

Linear regression, simple correlation, analysis of variance, general principles of field experimentation, completely randomized design, randomized block and Latin square designs.

Practicals:

Computation of A.M., Median and Mode for raw data and frequency distribution. Computation of S.D. and C.V. for raw data and frequency distribution. S.N.D. test for single mean and difference between two means, t-test for single mean, t-test for difference of two means, Paired t-test. Chi-square test for testing independence in (2x2) contingency table. Computation of simple correlation coefficient. Estimation of Regression lines. Analysis of C.R.D.,R.B.D. and L.S.D.

Suggested Readings:

1. S.R.S. Chandel (2003). Hand Book of Agricultural. Statistics. Achal Prakashan Mandir, Kanpur.
2. G.N. Rao (2007). Statistics for Agricultural Sciences. Oxford and IBH, Delhi.
3. S.C. Gupta (2006). Fundamentals of Statistics. Sultan Chand and Sons, New Delhi.
4. S. P. Gupta (2006) Statistical Methods. Sultan Chand and Sons, New Delhi.

COURSE NO. STAT - 521 DESIGN OF EXPERIMENTS-I
Cr.Hrs. 3(2+1)

Theory:

Basic principles of design of experiments, Uniformity trials and their uses, Fair field Smiths Variance Law and optimum size and shape of plots. Efficiency of basic designs. Factorial experiments: Symmetrical and Asymmetrical factorial experiments, 2^n factorial experiments, Yates method and general method of analysis of AxB and AxBxC factorial experiments.
Confounding in case of 2^n factorial experiments, Complete and partial confounding. Layout and analysis of Split and Strip plot design. Missing plot technique in R.B.D. and L.S.D. with one observation missing.

Progeny Row trial and compact family block design. Transformations: Square root, Logarithmic and Angular transformation. Analysis of Covariance.

Practicals :

Analysis of 2^2 and 2^3 experiments in R.B.D., Analysis of AxB factorial experiments. Analysis of AxBxC factorial experiments, Complete confounding in case of 2^3 experiments, Partial confounding in case of 2^3 experiments, Missing plot analysis in case of R.B.D. with one observation missing, Missing plot analysis in case of L.S.D. with one observation missing. Analysis of Split plot and Strip plot design, Analysis of Covariance in case of R.B.D. Use of transformations

Suggested Readings:

1. **K.A. Gomez and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons.**
2. **R.G.D. Steel and J.H. Torrie (1960). Principles and Procedures of Statistics. McGraw – Hill Book Co., New Delhi**
3. **V.G. Panse and P.V. Sukhtame (1985). Statistical Methods for Agricultural Workers. ICAR, New Delhi.**
4. **W.G.Cochran and G.M.Cox (1957). Experimental Designs. A Wiley International Edition. Canada.**

COURSE NO. STAT- 522 **ECONOMIC STATISTICS** **Cr.Hrs. 3(2+1)**

Theory :

Interpolation and Extrapolation – Definition, Assumption, limitations. Methods of interpolation graphic method, Newton's method of Advancing Difference, Newton Gauss Forward, Backward formula, Lagranges method, Newtons Divided Difference method.

Time Series Analysis- Meaning, importance and various components of time series, Trends: Straight line, Parabola, Exponential, Modified Exponential, Gompertz curve and Logistic curve, Measuring trend by graphic method, method of semi averages, method of moving average, Method of least squares. Measurement of seasonal variation: Method of Simple Average, Ratio to trend method, Ratio to moving average method, method of link relatives. Measurement of cyclic fluctuations by residue method and irregular movements.

Index number- Definitions, uses and limitations of Index Number, Types of Index Number, Problems in the construction of index number, Weighted and unweighted Index Number, (Index Numbers given by Laspayers, Paache's Kelley, Marshall Edgeworth and Fisher's Ideal Index Number), Quantity Index Numbers, Chain base Index Number, Conversion of fixed base Index Numbers into Chain base Index Number and vice versa. Time Reversal, Factor Reversal and Circular Tests.
Business Forecasting- Meaning and need of Business forecasting, Steps in forecasting, Methods of forecasting, Business Barometers, Theories of Business forecasting and utility of business forecasting, limitation of business forecasting and forecasting agencies.

Practicals :

Interpolation by advance difference formula, Interpolation by forward formula, Interpolation by backward formula, Interpolation by divided difference formula, Interpolation by Lagranges formula, Measurement of trend: Method of semi average and moving average method, Measurement of trend and least square method by fitting (i) $Y = a+bt$, (ii) $Y = a+bt+ct^2$ and (iii) $Y = ab^t$, Seasonal variation through (i) Moving average, (ii) Ratio to moving average, (iii) Ratio to trend method, (iv) Link relative method. Calculation of price index number by various formulae viz., Laspeyers, Paasche's method, Fisher's Ideal Index Number, Marshall Edgeworth method. Calculation of quantity index number. Time Reversal, Factor Reversal and Circular test of Index Number.

Suggested Readings:

1. **S.C. Gupta and V.K. Kapoor (2006). Fundamentals of Applied Statistics. Sultan Chand and Sons, New Delhi.**
2. **F.E. Croxton and D.J. Cowden (1988). Applied Statistics. Prentice Hall India.**
3. **V.K. Kapoor (2006). Fundamentals of Statistics for Business and Economics. Sultan Chand and Sons, New Delhi.**

COURSE NO.	**NONPARAMETRIC STATISTICS**	**Cr.Hrs.**
STAT- 523		**3(2+1)**

Theory :

The use of non-parametric statistical test in research, the one sample case, binomial test. χ^2- test, Kolmogorov Smirnov Test, run test, the case of two

related samples. McNemar test, sign test, Wilcoxon's Matched pairs test signed rank test, randomization test for matched pairs, the case of two independent samples, Fisher's exact probability test, χ^2- test, median test, Wilcoxon Mann- Whitney test, Kolmogorov Smirnov test, test for K related samples, the Cochran's Q- test and the Friedman two way analysis of variance for K samples. For K independent samples: χ^2- test, extension of median test, Kurskal-Wallis one way analysis of variance by ranks, measures of correlation, contingency coefficient, Spearman's and Kendall's Correlation Coefficient, Coefficient of Concordance.

Practicals :

Goodness of fit tests :

(a) Chi-square test procedure (b) Kolmogorov –Smirnov Procedures.

Inferences concerning Location based on one sample or paired samples :

(a) Sign test procedures, Binomial test

(b) Wilcoxon signed rank test for location, Confidence intervals for the median or median difference.

Inferences concerning location based on two or more samples :

(a) Mann-Whitney-Wilcoxon Procedures for two independent samples

(b) Kruskal Wallis Procedures for K independent samples.

Inferences concerning Scale Parameters:

(a) Siegel-Tukey test when medians equal or known,

(b) Procedures when medians unequal and unknown.

General distribution tests for two or more independent samples:

(a) Chi-square and Kolmogorov test procedures for two sample case.

(b) Extension of Chi-square and Kolmogorov-Smirnov Procedures,

(c) Test for equality of proportions.

Association analysis for two related or k related samples.

(a) Rank correlation, Kendall Tau Statistic. Coefficient of Concordance.

(b) Friedman Test, Measures of Association

Tests for randomness: run test, runs up and down procedures.

Suggested Readings:

1. **Sidney Siegel, N. John Castellan, Jr. (1988). Nonparametric Statistics for the Behavioral Sciences. McGraw-Hill International Editions.**
2. **W.W. Daniel (1978). Applied Nonparametric Statistics. Houghton Miffin Company, Boston.**
3. **J.D. Gibbons (1971). Nonparametric Statistics Inference. McGraw-Hill.Book Company, Kogacusha, Tokyo.**

COURSE NO.	RESEARCH METHODOLOGY	Cr.Hrs.
STAT- 621		3(2+1)

Theory :

Research Methodology: Meaning of research, Objectives of research, Types of research, Research approaches, Significance of research, Research and Scientific method, Research process, Inductive and deductive methods, Criteria of good research.

Research Problem Formulation : Research reviews, hypothesis, synopsis and research methods. Collection of research data : Primary v/s secondary data, time series data, cross-sectional data and panel data, Various sources of Agricultural data, Census, schedules and questionnaire pre-tests, pilot study and inter disciplinary researches.

Scores and Scaling Techniques: Need for scaling, problems of scaling – continuum, reliability, validity and weighting methods of scaling.

Quantitative techniques: Growth rates, instability analysis, functional relationship-linear, quadratic, exponential and polynomial models.

Introduction to multivariate statistical methods, mean vectors, Variance-covariance matrix, discriminate function, factor analysis.

Sampling: Meaning and importance, Sampling techniques, determining size of the sample

Practicals :

Research problem formulation, Review of a research study, Formulation of a research topic, objectives, hypothesis and design of research for given research problem. Preparation of research project proposal, Collection of secondary data for a research topic. Analysis of secondary data for the above. Collection of primary data (survey data) for a research topic. Analysis of primary data for the above. Numerical application on scores and scaling techniques.

Suggesting Readings:

1. **C.R. Kothari (2006). Research Methodology. Wiley Eastern Limited, Daryaganj, New Delhi**
2. **S.R. Bajpai (1984). Methods of Social Survey and Research. Kitab Ghar, Acharyanagar, Kanpur**
3. **S.P. Singh and S.P.S. Verma (1983).. Agricultural Statistics. Rana Publishing House, Baraut (Meerut).**

4. **S.S. Acharya and G.M.K. Madanani (1988). Applied Econometrics for Agricultural Economists. Himanshu Publications, Udaipur.**

COURSE NO. STAT-622 DESIGN OF EXPERIMENTS- II Cr.Hrs. 3(2+1)

Theory:

Confounding in 3^3 and 3^4 factorial experiment in 9 plot blocks; Confounding in asymmetrical factorial experiments e.g. 3x2x2 and 3x3x2 in six plot blocks; Fractional replication in factorial experiment e.g. 2^5 in ½ replicate, 2^5 in ¼ replicate, 3^3 in 1/3 replicate. Confounding in split plot design; Analysis of non-orthogonal data; Incomplete block designs; BIBD, simple lattice; Youden square design; Switch over designs with or without residual effect; Response surface study and first and second order designs; Central composite rotatable designs of second order; Method of determining optimum combination of factor levels; Group of experiments; Long term experiments; Rotational experiments.

Practicals :

Confounding in 3^3 in 9 plot blocks (Total and Partial), Confounding in 3x 2 x 2 or
3 x 3 x 2 in 6 plot blocks, Fractional replication in 2^5 in ½ replicate or 2^6 in ¼ replicate, Confounding in split plot design, Analysis of B.I.B.D, simple lattice Switch over trial, Response surface study for second order rotatable design, Groups of experiments, Long term experiments, Experiments on cultivator's field

Suggested Readings:

1. **M.N. Das and N.C. Giri (1979). Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi.**
2. **W.G., Cochran and G.M. Cox (1959). Experimental Design. Asia Publishing House, Bombay.**
3. **O.Kempthorne (1974). The Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi, 2nd. Ed.**
4. **B.J. Winer (1962). Experimental Design. McGraw-Hill Book Co., New York.**
5. **W.T. Federer (1962). Experimental Design. Oxford and IBH, New Delhi.**
6. **A. Dey (1986). Theory of Block Designs. Wiley Eastern Ltd., New Delhi.**

COURSE NO. STAT- 623 ECONOMETRICS Cr.Hrs. 3(3+0)

Theory :

Concept of econometric model, mathematical model v/s econometric model, error term and its assumption. Concept of stochastic and deterministic models, Time series and cross section models, Study of linear regression model, Maximum likelihood and least square estimation, Bias and precision of the regression estimates, Specification problems, Serial correlation, Problems of multicollinearity, Heteroscedasticity, Lagged variables, Dummy variables, Use of instrumental variables, Input-Output models, Production functions.

Suggested Readings:

1. J. Johnston(1967). Econometric Methods. McGraw Hill Book Co., New York.
2. L.R. Klien.(1974). A Text Book of Econometrics. Prentice HaIl, Englewood cliffs.
3. P. Rao and R.L. Miller (1971). Applied Econometrics. Wadsworth Publishing Co. Belmont, Calif.
4 S.S. Acharya and G.M.K. Madanani (1988). Applied Econometrics for Agricultural Economists. Himanshu Publications, Udaipur.

COURSE NO. STAT- 624 PSYCHOMETRICS Cr.Hrs. 3(3+0)

Theory :

Psychological tests : Meaning of test and scale, Types of tests in social research, Projective and non projective tests, Procedures for developing a test, Item analysis : Item collection, discrimination and difficulty indices, Tests of item validation and final item selection, Types of scores and their standardization, Reliability and validity of tests and scales : meaning, kinds and techniques of measuring different kinds of reliability and validity in social research, Social distance scale, socio-economic status scale, Adoption quotient, Social participation scale, communication fidelity index, rationality quotient etc., Critical incident technique : meaning, its applicability and procedures involved, Q-sort technique : meaning, its applicability

Suggested Readings:

1. **H.E. Garret (1966). Statistics in Psychology and Education. Vakils, Fetter and Simms Ltd.**
2. **C.A. Moser and G. Kalton (1979). Survey Methods in Social Investigation. The ELBS and Heinemarnn Educational Books.**
3. **F.N. Karlinger (1983). Foundation of Behavioral Research. S.S. Chhabra Publication. New Delhi.**
4. **A.M. Goon, M.K. Gupta and B. Dasgupta (1979). Fundamental of Statistics. The World Press, Calcutta.**

UG COURSES: **2007-08** **Annexure-I**

Year	Semester	Course No	Title	Cr. Hr.
First	First	PBG 111	Principles of Genetics	3 (2+1)
Second	First	PBG 211	Principles of Plant Breeding	3 (2+1)
Second	Second	PBG 221	Breeding of Field and Horticultural Crops	3 (2+1)
Third	First	PBG 311/MBBT	Principles of Plant Biotechnology (To be jointly shared between PBG & MBBT)	3 (2+1)
Third	Second	PBG 321	Principles of Seed Technology	3 (2+1)
Forth	Second	PBG 411*	Heterosis & Hybrid Seed Production in Field Crops	3 (1+2)
Forth	Second	PBG 412*	Molecular Genetics	3 (2+1)

*Elective Courses.

Details :

UG COURSES: **2007-08** **Annexure-I**

Sr. No.	Course No.	Title	Cr. Hr.	Maximum Marks			Total Marks	Rem-arks
				Th	Pr	*MT		
1.	PBG 111	Principles of Genetics	2+1=3	50	30	20	100	
2.	PBG 211	Principles of Plant Breeding	2+1=3	50	30	20	100	
3.	PBG 411	Agrobiodiversity Input act WTO in farmers context	2+0=2	80	-	20	100	
4.	PBG 431	Heterosis & Hybrid Seed Production in Field Crops	2+1=3	50	30	20	100	

5.	PBG 432	Molecular Genetics	2+1=3	50	30	20	100	

*MT = Mid-Term Examination

PG COURSES: **2007-08** **Annexure-II**

S.No.	Course No.	Title	Cr. Hr.
OPTIONAL COURSES			
1	**PBG.621**	**Seed Certification & Germplasm Conservation**	**3 (2+1)**

2	**PBG.622**	**Theory & Advances in Plant Breeding**	**3 (3+0)**
3	**PBG.623**	**Molecular Breeding in Crop Improvement**	**3 (2+1)**
4	**PBG.624**	**Population Genetics**	**3 (3+0)**
5	**PBG.625**	**Principles of Cytogenetics**	**3 (2+1)**
6	**PBG.626**	**Breeding for Quality and Special Characters**	**3 (3+0)**
7	**PBG.627**	**Breeding for Pulses & Oilseeds**	**3 (3+0)**
8	**PBG.628**	**Breeding for Vegetables & Fruits**	**3 (2+1)**
9	**PBG.631**	**Heterosis Breeding**	**3 (2+1)**
10	**PBG.632**	**Breeding for Biotic & Abiotic Stresses**	**3 (2+1)**
11	**PBG.633**	**Mutagenesis**	**3 (2+1)**
12	**PBG.634**	**Applied Crop Cytogenetics & Genome Analysis**	**3 (2+1)**
13	**PBG.635**	**Breeding for Cereals & Millets**	**3 (3+0)**
14	**PBG.636#**	**Molecular Genetics**	**3 (3+0)**
15	**PBG.637**	**Improvement of Field Crops**	**3 (2+1)**
16	**PBG.638**	**Breeding for Fibre, Forage, Seed Spices & Vegetatively Propogated Crops**	**3 (3+0)**
17	**PBG.639**	**Fundamentals of Genetics & Plant Breeding**	**3 (2+1)**
18	**PBG.641**	**Comprehensive / Prelimary**	**NC**
19	**PBG.642**	**Seminar**	**02** / **01***
20	**PBG.643**	**Research**	**45** / **15***
CORE COURSES			
21	**PBG.611**	**Principles of Genetics**	**3 (2+1)**
22	**PBG.612**	**Principles of Quantitative Genetics**	**3 (2+1)**
23	**PBG.613**	**Principles of Plant Breeding**	**3 (2+1)**
24	**PBG.614**	**Biometrical Genetics**	**3 (3+0)**
25	**PBG.615**	**Advances in Plant Genetics**	**3 (3+0)**

****Ph.D. & M.Sc. (Ag) PBG**

 # Core Course

Details:

PG COURSES: **2007-08** **Annexure-II**

Sr. No.	Course No.	Title	Cr. Hr.	Maximum Marks			Total Marks	Rem--arks
				Th	Pr	*MT		
1.	PBG 611	Principles of Genetics	2+1=3	50	30	20	100	
2.	PBG 612	Principles of Quantitative Genetics	2+1=3	50	30	20	100	
3.	PBG 613	Principles of Plant Breeding	2+1=3	80	30	20	100	
4.	PBG 636	Molecular Genetics	3+0=3	80	-	20	100	I Sem. Common for MBBT
5.	PBG 614	Biometrical Genetics	3+0=3	80	-	20	100	Ph.D.
6.	PBG 615	Advances in Plant Genetics	3+0=3	80	-	20	100	Ph.D.
Optional Courses:								
7.	PBG.621	Seed Certification & Germplasm Conservation	2+1=3	80	30	20	100	
8.	PBG.622	Theory & Advances in Plant Breeding	3+0=3	80	-	20	100	
9.	PBG.623	Molecular Breeding in Crop Improvement	2+1=3	80	30	20	100	
10.	PBG.624	Population Genetics	3+0=3	80	-	20	100	
11.	PBG.625	Principles of Cytogenetics	2+1=3	80	30	20	100	
12.	PBG.626	Breeding for Quality and Special Characters	3+0=3	80	-	20	100	Ph.D.
13.	PBG.627	Breeding for Pulses & Oilseeds	3+0=3	80	-	20	100	Ph.D.
14.	PBG.628	Breeding for Vegetables & Fruits	2+1=3	80	30	20	100	
15.	PBG.631	Heterosis Breeding	2+1=3	80	30	20	100	
16.	PBG.632	Breeding for Biotic & Abiotic Stresses	2+1=3	80	30	20	100	

17.	PBG.633	Mutagenesis	2+1=3	80	30	20	100	
18.	PBG.634	Applied Crop Cytogenetics & Genome Analysis	2+1=3	80	30	20	100	
19.	PBG.635	Breeding for Cereals & Millets	3+0=3	80	-	20	100	Ph.D.
20.	PBG.637	Improvement of Field Crops	2+1=3	80	30	20	100	
21.	PBG.638	Fibre,Forage,Seed Spices & Vegetatively Propogated Crops	3+0=3	80	-	20	100	
22.	PBG.639	Fundamentals of Genetics & Plant Breeding	2+1=3	80	30	20	100	
23.	PBG.641	Comprehensive / Prelimary	NC					
24.	PBG.642	Seminar	02** / 01*					
25.	PBG.643	Research	45** / 15*					

PBG 111 PRINCIPLES OF GENETICS 3 (2+1)

Theory:

History OF Genetics. Ultra structure of cell. Cell organelles and their function. Chromosome structure, function and chemical composition – karyotype and ideogram. Cell division : types and their significance. DNA and its structure, function, types, mode of replication and repair. RNA and its structure, function and types, transcription, translation, genetic code and protein synthesis.

Mendel's laws of inheritance. Gene interaction and their types. Multiple alleles and some classical examples. Inheritance of quantitative and qualitative characters and differences between them. Multiple factor hypothesis. Pleiotropism, penetrance and expressivity. Cytoplasmic inheritance – its characteristic features and difference between chromosomal and cytoplasmic inheritance. Mechanism of crossing over and cytological proof of crossing over. Linkage-types and importance. Estimation of linkage. Numerical chromosomal aberrations (polyploidy) and evolution of different crop species like cotton, wheat, tobacco and brassicas. Structural chromosomal aberrations. Mutation-characteristics, classification and induction.

Practical:

Introduction to Microscopy - Simple and compound microscope. Study of typical plant cell. Preparation and use of fixatives and stains. Preparation of micro slides and identification of various stage of cell division. Monohybrid ratio and its modification. Dihybrid ratio and its modification. Test of goodness of fit of genetic ratio. Study of different types of gene interactions and modifications of typical dihybrid F_2 ratios. Study and detection of linkage in F_2 and test cross progeny. Induction of polyploidy using colchicines. Induction of chromosomal aberrations using chemicals.

Suggested Readings:

- **Gupta, P.K. 2004. Cytology, Genetics and evolution. Rastogi Publications, Meerut.(Hindi Edition).**
- **Kaushik, M.P. 2003. A Text Book of Modern Botany. Prakash Publications, Muzaffarnagar (U.P.).**
- **Klug, W.W. and Cummings, M.R. 2005. Concepts of genetics Pearson Education (Singapore) Pvt. Ltd., Indian Branch, Pratap Ganj, New Delhi.**
- **Singh, B.D. 2001. Fundamentals of Genetics, Kalyani Publishers, New Delhi.**
- **Strickberger, M.W. 2001. Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.**

PBG 211 PRINCIPLES OF PLANT BREEDING 3(2+1)

Theory:

Introduction to ecological and taxonomical classification of plants. Historical development, nature and role of plant breeding. Modes of reproduction (sexual, asexual and vegetative) and their relation with plant breeding. Fertility regulatory mechanisms (incompatibility, male sterility and apomixis), their classification and importance in plant breeding. Inheritance of qualitative and quantitative characters and heritability. Pure line theory and genetic basis of selection. Hardy-Weinberg law, heterosis and theories of heterosis and inbreeding depression. Germplasm resources and center of diversity. Domestication, introduction and acclimatization in relation to plant improvement.

Improved genotypes of different crop plants- variety, inbred line, different hybrids, synthetic, composite, multiline, clone etc. Different breeding methods of their development. Polyploidy in relation to plant breeding. Mutation breeding- types, role and method of mutation breeding. Use of biotechnology in plant breeding. Procedure for release of new varieties.

Practical:

Identification of plants of different ecological groups. Floral biology of different crop plants. T.S. of overy. Mounting of different types of ovules. Study of microsporogenesis and megasporogenesis. Study of pollen viability. Study of pollen size. Emasculation and hybridization techniques in important self and cross pollinated crops. Study of male sterility in sorghum. Calculation of mean, range, variance and standard deviation.

Suggested Readings:

- Alard, R.W. 2000. Principles of Plant Breeding. John Willey & Sons, New York.
- Chahel, G.S. and S.S. Gosal. 2002. Principles and Procedures of Plant Breeding, Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi.
- Singh, B.D. 2005. Plant Breeding. Kalyani Publishers, New Delhi.
- Singh, P. 2001. Essentials of Plant Breeding - Principles and Methods. Kalyani Publishers, New Delhi.

PBG 221 BREEDING OF FIELD AND HORTICULTURAL CROPS 3(2+1)

Theory:

Botany and taxonomy, chromosome number, center of origin, species relationship, floral biology, breeding objectives and constraints, disease and pest resistance and quality (physical, chemical, nutritional and marketing) improvement, conventional and non-conventional breeding methods, important varieties and future thrust area in crops like wheat, rice, maize, pearlmillet, soybean, groundnut, mustard, cotton, sugarcane, potato, tomato, rose, marigold, mango, papaya and amla.

Practical:

Study of floral biology, hybridization technique, germplasm and segregating populations. Layout of breeding experiments. Observation recording, analysis and interpretation of breeding trials. Calculation of variability parameters, heterosis and inbreeding depression. Salient features of varieties recommended for the region for the crops viz., rice, wheat, maize, sorghum, groundnut, cotton, potato, tomato, sugarcane, rose, marigold, mango and papaya (available at the time of semester).

Suggested Readings:

- Chaddha, K.L. and Rajendra Gupta. 1995. Advances in Horticulture Vol. II Medicinal and Aromatic Plant. Malhotra Publishing House, New Delhi.
- Chopra, V.L. 2000. Breeding of Field Crops (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Mandal, A.K., P.K. Ganguli and S.P. Banerjee. 1991. Advances in Plant Breeding Vol. I and II. CBS Publishers and Distributors, New Delhi.
- Manjit S. Kang 2004. Crop Improvement: Challenges in the Twenti-First Century (Edt). Internatinal Book Distributing Co.Lucknow.
- Poehlman, J.M. 1987. Breeding of Field Crops. AVI Publishing Co.. INC, East Port, Conneacticut, USA.
- Ram, H.H. and H.G. Singh. 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.
- Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.
- Ram, H.H. 2005. Vegetable Breeding – Principles and Practices. Kalyani Publishers, New Delhi.

PBG 311 PRINCIPLES OF PLANT BIOTECHNOLOGY 3 (2+1)

Theory:

Concepts of Plant Biotechnology : History of Plant Tissue Culture and Plant Genetic Engineering : Scope and importance in Crop Improvement : Totipotency and Morphogenesis, Nutritional requirements of in-vitro cultures; Techniques of In-vitro cultures, Micropropagation, Anther culture, Pollen culture, Ovule culture, Embryo culture, Test tube fertilization, Endosperm culture, Factors affecting above in-vitro culture; Applications and Achievements; Somaclonal variation, Types, Reasons, Somatic embryogenesis and synthetics seed production technology; Protoplast isolation, Culture, Manipulation and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement; Genetic engineering; Restriction enzymes, Vectors for gene transfer, Gene cloning, Direct and indirect method of gene transfer – Transgenic plants and their applications. Introductory knowledge about blotting techniques, molecular markers, QTL, Marker assisted selection and application in crop improvement.

Practical:

Requirements for plant Tissue Culture Laboratory : Techniques in plant Tissue Culture – Media components and preparation; Sterilization techniques and inoculation of various explants, callus induction and plant regeneration; Demonstration of Micropropagation, Anther culture, embryoculture, Hardening/Acclimatization of regenerated plants, somatic embryogenesis and synthetic seed production; Demonstration of isolation and culture of protoplast; Demonstration of isolation of DNA, gene transfer technique and gel electrophorosis techniques.

Suggested Readings:

- Brown, T.A. 2001 Gene Cloning and DNA analysis – An Introduction. Blackwell Science. London.
- Gupta, P.K. 2006 Biotechnology and Genomics. Rastogi Publication, Merrut.
- Purohit, S.S. 1997. Biotechnology. Agro Botanical Publication. Bikaner.
- Rajdan, M.K. 1996 An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Ramawat, K.G. 2000. Plant Biotechnology. S. Chand and Company, New Delhi.
- Singh, B.D. 2001 Biotechnology. Kalyani Publishers. Ludhiana.

PBG 321 PRINCIPLES OF SEED TECHNOLOGY 3(2+1)

Theory :

Importance of improved seed in agriculture. Seed technology – definition, objective, relationship with other sciences. Seed quality - definition, characters of good quality seed and classes of seed. 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. Steps involved in development of seed programme and seed multiplication. Production of nucleus & breeder seed, Maintenance and multiplication of pre-release and newly released varieties in self-and cross-pollinated crops. Seed Production - foundation and certified seed production of maize, bajra, sorghum (hybrids, synthetics and composites), rice, cotton, tomato and hybrids; chillies and cucurbits (varieties and hybrids): Seed production of wheat, barley, gram and rapeseed mustard. Seed certification, phases of certification, procedure for seed certification and field inspection, field counts. Seed Act 1966 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. Intellectual Property Rights, Patenting, WTO, Plant Breeders Rights and Farmer's Right. 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. Seed processing - planning and establishment of seed processing plant; air screen machine and its working principle, different upgrading equipment and their use. Seed treatment – importance, types of seed treatment, equipment used for seed treatment (Slurry and Mist-O-matic

treater) Seed storage; stages of seed storage, factors affecting seed longevity during storage and conditions required for good storage, general principles of seed storage. Seed marketing - marketing structure, marketing organization, sales generation activities, promotional media, pricing policy and Factors affecting seed marketing.

Practical:

Seed sampling principles and procedures; Physical Purity analysis of Field and Horticultural crops; Moisture test Germination analysis and viability test of Field and Horticultural crops; Vigour tests of Field and Horticultural crops; KOH and NaOH test for varietal identification; Visit of GOT fields at University farms. Visit to Seed production plots of University Farms. Visit to Seed processing plant; Seed testing laboratories; Varietals identification in seed production plots; Planting ratios, Minimum seed certification standards of important crops of University Farms.

Suggested Readings:

- Agarwal, R.L.1991. Seed Technology, Oxford & IBH Publishing Co. Delhi.
- Agarwal, P.K.1999. Seed Technology, ICAR, New Delhi.
- Tomar, H.S. Beej Prodhyogiki, Aman Publishing House.

PBG 411 HETEROSIS AND HYBRID SEED PRODUCTION IN FIELD CROPS 3 (1+2)

Theory:

Heterosis breeding – heterotic pools and populations, their development and improvement. Inbred lines – development, evaluation, improvement, nature and number of testers, combining ability. Type of hybrids, their development and prediction of hybrid performance. Male sterility and self-incompatibility system, their development, maintenance and exploitation in hybrid breeding. Hybrid seed production – field layout, isolation, rouging, characterization of inbred lines. Use of male sterility systems, two and three line system of hybrid seed production, development of A, B and R lines. Current status and future prospects of hybrid development in maize, bajra, cotton, sorghum, wheat, rice, castor, mustard, sunflower, pigeonpea and vegetable crops (okra, brinjal, tomato).

Hybrid seed production – identification of seed production areas and factors affecting seed production.

Practical:

Floral biology, study of controlled pollination and different techniques of emasculation. Crossing and selfing technique in different field crops. Field layout of crossing block in self pollinated crops. Field layout of crossing block in cross-pollinated crops. Field layout of hybrid seed production with and without male sterility system. Development of inbred lines in maize. Maintenance of A, B and R lines. Characterization and identification of parents and hybrids. Varietal identification in field crops.

Suggested Readings:

- Agarwal, R.L. 1991. Seed Technology. Oxford & IBH Publishing Co. New Delhi.
- Chaddha, K.L. and Rajendra Gupta. 1995. Advances in Horticulture Vol. II Medicinal and Aromatic Plant. Malhotra Publishing House, New Delhi.
- Chopra, V.L. 2000. Breeding of Field Crops (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Hallauer A.R. and Miranda, J.B. 1989. Quantitative Genetics in Maize. Iowa State Univ. Press Amesterdum.
- Poehlman, J.M. 1987. Breeding of Field Crops. Third Edition, AVI Publication, USA.
- Ram, H.H. 2005. Vegetable Breeding – Principles and Practices. Kalyani Publishers, New Delhi.
- Sharma, J.R. 1994. Principles and Practices of Plant Breeding. Tata-Mc Graw Hill Publication, New Delhi.

PBG 412 MOLECULAR GENETICS 3 (2+1)

Theory:

Molecular genetics, early evidences establishing nucleic acid as genetic material. Physico-chemical organization, methodological approach and properties of DNA & RNA. Replication of DNA in

pro and eukaryotes including proof reading functions of polymerases. DNA repair. Genetic code and molecular basis of mutation. Genetic recombination in bacteria, genetic fine structure and definition of gene. Protein synthesis; transcription and translation. Gene expression and regulation of gene expression in pro and eukaryotes. Split genes, m RNA processing. Transposable elements. Essentials of genetic engineering; restriction enzymes, vectors, DNA sequencing, gene isolation, methods of gene transfer and development of transgenics. Applications of genetic engineering. Structural and functional genomics. Proteomics.

Practical:

Laboratory requirements, laboratory techniques – preparation of solutions & buffers. Handling of equipments – spectrophotometer charomatography, electrophoresis, centrifugation etc. Demonstration of isolation of genomic DNA from plant tissue, digestion of DNA, preparation of agarose gel for electrophoresis. Demonstration of transformation, PCR techniques.

Suggested Readings:

- Brown, T.A. 1998. Genomes. John Wiley and Sons (East Asia), Singapore.
- Freifelder, D. 2004. Molecular Biology, Narosa Publishing House, New Delhi.
- Gardner, E.J., Simmons M.J. and Peter Snouted, D. 1995. Principles of Genetics, John Wiley and Sons, New York.
- Karp, G. 2002. Cell and Molecular Biology, John Wiley & Sons, Inc. VAN Hoffman Press, Newyork.
- Lewin, B. 2005. Genes VII. Oxford University Press, New York.
- Primrose S.B. and Twyman R.M. 2003. Principle of Genome Analysis and Genomics. Blackwell Publishing, Italy.
- Primrose, S.B., Twyman, R.M. and Old, R.W. 2004. Principle of Gene Manipulation. Blackwell Publishing, Italy.
- Primrose, S.B. and Twyman, R.M. 2006. Principle of Gene Manipulation and Genomics Blackwell Publishing, Italy

PBG 611 PRINCIPLES OF GENETICS 3 (2+1)

Theory:

Historical perspective on Genetics. Mendelian principles; Gene interactions; Linkage: detection and estimation in various organisms. Multiple alleles. Mechanisms of sex determination- Sex linked, sex- influenced and sex-limited traits. Inter-genic and intra-genic complementation, recombination and complex loci. Fine structure of gene; Genetic control of metabolism. Gene-protein-polypeptide relationships. Genetic material: nature, organization, structure and replication. Genetic code transcription and translation. Gene regulation in prokaryotes and eukaryotes with models. Split genes, alternative splicing, transcriptional and post-transcriptional regulation. Mobile genetic elements and dynamic nature of genome. Mutations: induction, detection and mechanisms. Environmental influence on gene expression. Extra nuclear inheritance. Polygenic inheritance. Population genetics: Hardy-Weinberg equilibrium, changes in gene and genotype frequencies. Human genetics: genetic disorders and gene therapy. Introduction to recombinant DNA technology.

Practical:

Demonstration of Mendelian principles using Drosophila/plant systems. Modification of dihybrid ratios using maize as model system. Multiple alleles. Analysis of penetrance and expressivity (PTC test). Linkage and gene mapping using Drosophila/Neurospora. Numerical exercises related to Mendelian principles, gene interactions, linkage and gene mapping. Induction and detection of sex-linked recessive lethal. Analysis of quantitative inheritance in plant. Isolation of DNA. Demonstration of molecular marker techniques.

Suggested Readings:

- Griffiths, A.J.F.; Miller, J.H.; Suzuki, D.T.; Lewontin, R.C. and Gelbart W.M. 1996. An Introduction to Genetic Analysis (6th Edition). W.H. Freeman, New York.

- Jain, H.K. 1999. Genetics – Principles, Concepts and Implications. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Lewin, B. 2004. Genes VIII. Pearson Prentice Hall (USA).
- Singh, B.D. 2006. Fundamentals of Genetics. Kalyani Publishers, Ludhiana.
- Strickberger, M.W. 2002. Genetics. Prentice Hall of India Pvt. Ltd. New Delhi.

PBG 612 PRINCIPLES OF QUANTITATIVE GENETICS 3(2+1)

Theory:

Historical background of quantitative inheritance. Probability laws and distributions. Elementary concepts of matrix theory, modulation of equation through matrix theory (linear models). Expectation of fixed and random effect models. Partitioning of mean and variances. Single gene and multiple gene models-estimation of genetic parameters and scaling tests. Covariance between relatives. Gene and genotype frequency- Hardy-Weinberg law, mean and variance. Heritability, selection differential, response to selection and correlated response. Concept of combining ability and its relevance to gene action. Inbreeding and heterosis- simple model and extension to polygenic situations. Mating designs- Diallel, North Carolina, Line x Tester and Triple test cross. Genotype x environment interaction and stability analysis. Correlation, path coefficient, Selection indices and Genetic divergence.

Practical:

Probability laws. ANOVA fixed and random effect model. Mean and variance in different populations (self, sib, backcross and F_2). Partioning of variance. Analysis in North Carolina Designs, Diallel and L x T. Estimation of heritability, Selection intensity and Selection response. Analysis and interpretation of Correlation, Regression, Path coefficient and D^2. Use of computer package.

Suggested Readings:

- Comstock, R.E. 1996. Quantitative Genetics with Special Emphasis on Plant and Animal Breeding. Iowa State University Press, Iowa.
- Falconer, D.S. and Mackay, J. 1996. Introduction to Quantitative Genetics, Longman Group Ltd., London.
- Mather, K. and Jinks, J.L. 1971. Biometrical Genetics. Chapman and Hall, London.

- Roy, D. 2000. Plant Breeding – Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
- Sharma, J.R. 1998. Statitical and Biometrical Techniques in Plant Breeding. New Age International Publishers, New Delhi.
- Singh, R.K. and Chaudhary, B.D. 1997. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.

PBG 613 PRINCIPLES OF PLANT BREEDING 3 (2+1)

Theory:

Introduction of plant breeding – history and objectives. Plant introduction, domestication and acclimatization. Center of origin. Germplasm collection, evaluation and conservation. Gene pool concept. Mechanisms controlling pollination and their consequences – mode of reproduction, male sterility and self incompatibility .Mating system and their genetic consequences Breeding self pollinated crops – methods, their basic and achievements. Pure line theory and concept of pure line. Mass selection, pure line selection, pedigree selection, bulk method, single seed descent and back cross method. Population breeding – population and role of population, intra and inter population improvement methods. Hybrid breeding – gene pool development, development of inbreds, production of hybrid, improvement of inbreds and achievements. Synthetic varieties. Breeding vegetatively propagated crops. Role of Mutation in Plant Breeding. Application of biotechnology in plant breeding. Intellectual property rights in relation to plant breeding.

Practical:

Field plot techniques and layout for varietal evaluation trials. Augmented design, adjacent plot techniques, Moving average and honey comb design. Observation recording, analysis and interpretation of plant data. Extent of natural crossing – its measurement. Emasculation and pollination techniques in important crop species. Pollen viability test (Staining in in-vitro and germination). Study of pollen size and shape. Maintenance of male sterile lines. Practical knowledge of breeding projects in operations.

Suggested Readings:

- Allard, R.W. 1960. Principles of plant breeding. John Wiley and Sons, New York.
- Chopra, V.L. 1989. Plant Breeding. Oxford and IBH Publishing Co., New Delhi.
- Poehlman, J.M. 1987. Breeding field crop (3rd Ed.). AVI Publishing Co., INC, West Connecticut, USA.
- Roy, D. 2000. Plant Breeding, Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
- Singh, B.D. 2001. Plant Breeding, Kalyani Publishers, New Delhi.
- Sharma, J.R. 1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing Co., Ltd., Delhi.

PBG 614 **BIOMETRICAL GENETICS** **3(3+0)**

Theory:

A detailed study of variability, its nature, origin and measurement. Generation means and analysis of gene effects. Principles of second degree statistics in relation to biometrical genetics. Balance sheet of variation in different generations. Development of mating designs. Weighted analysis. Genetic divergence, its estimation and importance in plant breeding. Genotype-environment interaction, its estimation and importance in plant breeding. Analysis and interpretation of mating designs – Diallel, Partial diallel, Line x Tester, NCD I, II & III, Tripal test cross, Three way and Double cross. Marker assisted selection and QTL analysis. Stability parameters, estimation and inlocpretation.

Suggested Readings:

- Comstock, R.E. 1996. Quantitative Genetics with Special Emphasis on Plant and Animal Breeding. Iowa State University Press, Iowa.
- Falconer, D.S. and Mackay, J. 1996. Introduction to Quantitative Genetics, Longman Group Ltd., London.
- Mather, K. and Jinks, J.L. 1971. Biometrical Genetics. Chapman and Hall, London.
- Roy, D. 2000. Plant Breeding – Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
- Sharma, J.R. 1998. Statistical and Biometrical Techniques in Plant Breeding. New Age International Publishers, New Delhi.
- Singh, R.K. and Chaudhary, B.D. 1997. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi.

PBG 615 ADVANCES IN PLANT GENETICS 3(3+0)

Theory:

Secondary structure of DNA (A, B, C, Z and P-DNA), Denaturation and renaturation of DNA, Secondary and tertiary structures of RNA. Physico-chemical organization of chromatin, nucleosome concept and higher order organization of chromatid. Mobile genetic elements in pro- and eukaryotes and their significance. Aims and principles of gene transfer, vectors, restriction enzymes, distinguishing transferred genes from endogenous genes. *In vitro* synthesis of recombinant DNA and gene cloning.

Gene transfer methods – Agrobacterium mediated and direct gene transfer method. Role of genetic engineering – transgenic crops, current status and prospects, potential hazards of gene cloning. Construction of genomic libraries. Molecular markers, types and significance. Genome projects, genomics and proteamics. Bioinformatics.

Suggested Readings:

- Brown, T.A. 1998, Genomes. John Wiley and Sons (East Asia). Singapure.
- Brown, T.A. 2001, Gene Cloning and DNA Analysis-An Introduction. Black Well Science. London.
- Freifelder, D. 1995. Molecular Biology. Narosa Publishing House, New Delhi.
- Karp. G. 1999. Cell and Molecular Biology. John Wiley and Sons, (East Asia) Singapure.
- Lewin. B. 2004. Genes VIII. Pearson Printice Hall, USA.
- Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene Manipulation and Genomics, 7th ed. Black Well Science Publishing.
- Singh, B.D. 2006. Fundamental of Genetics. Kalyani Publishing, New Delhi.

PBG 621 SEED CERTIFICATION AND GERMPLASM CONSERVATION 3(2+1)

Theory:

History of seed Industry in India and role of various seed organizations. Indian seed act and Enforcement and Jurisdiction. Notification of a variety. General principles of seed production. Maintenance of Nucleus and Breeder seed. Production of Foundation seed. Production of Certified seed.

Minimum field and seed certification standard. Agrobiodiversity, ecosystem diversity in India. Centre of origin and crop plant diversity. Importance of genetic diversity and its erosion. Gene pool : Primary, secondary and, tertiary. Principles, strategies and practices of exploration, collection, characterization evaluation and cataloguing of PGR. Plant quarantine and phyto-sanitory certificate. Germplasm introduction and exchange. Germplasm conservation: in situ, ex situ. PGR access and benefit sharing : IPR, PBR, Farmer's right and CBD issues. National and international exploration activities.

Practical:

Seed sampling, heterogenity test .Seed testing-moisture percentage,physical purity, germination percentage, Real value of seed. Seed viability test, Seed vigour test –direct vigour test, accelerated paging, indirect vigour test. Seed dormancy and methods of its breaking. Seed production technique in important crop plants –maize, sorghum, pearlmillet, wheat,mustard ,pigeonpea, cotton. Determination of cultivar purity –phenol color test in wheat , KOH bleach test of sorghum .Visit to seed technology laboraty and grading & processing units. Characterization of germplasm.

Suggested Readings:

- Agarwal, R. L. 1991. Seed Technology, Oxford & IBH Publishing Co. Delhi.
- Agarwal, P.K. 1999 Seed Technology, ICAR, New Delhi.
- Kulkarni, G.N. 2004. Principles of Seed Technology. Kalyani Publishers, New Delhi.
- Rao, N. Kameswara and Bramel, Paula J. 2000. Manual of Genebank Operations and Procedures. Technical Manual No. 6. ICRISAT, Patancheru, A.P., India.

- Singh, B.D. 2005. Fundamental of Genetics. Kalyani Publishing, New Delhi.
- Sustainable Management of Plant Biodiversity. Lecture Notes (2nd Trainers Training Programme) NATP Cell, NBPGR, New Delhi.

PBG 622 THEORY AND ADVANCES IN PLANT BREEDING 3(3+0)

Theory:

Components of variation and their estimation. Additive, non-additive and epistatic components. Variance components among early and advanced generation of segregating populations. Effective population size – their significance in decision making in plant breeding. Selection theory: Types of selection, response to selection, selection advance, criteria of selection, selection limits, direct and indirect selection, multitrait selection and construction of selection index, correlated response. Heterosis - Genetic basis, prediction and estimation of heterosis. Genetic divergence and its estimation.

Breeding methods of self-pollinated crops and their genetic consequences. Multiline – clean and dirty crop approach, genetic consequences, advantages and disadvantages. Breeding methods of cross-pollinated crops- population improvement, intra-population improvement and inter-population improvement. Breeding composite and synthetic populations. Hybrid breeding-Hybrids in self and cross-pollinated crops – their genetic basis, heterotic pool concept; development and improvement of heterotic pools. Inbred lines-evaluation of inbred lines and hybrid development. Apomixes in fixing heterosis.

Mating designs - Diallel, North Carolina designs, line X tester mating design and three-factor mating designs. Genotype X Environment interaction - Analysis of variance over multiple environments,

stability models – Regression approaches, estimation of stability indices; Best linear unbiased prediction (BLUP).

Molecular marker assisted selection (MAS) - Types of molecular markers, their inheritance and mapping molecular markers, MAS for abiotic and biotic stress resistance. Quantitative Trait Loci (QTLs) – Mapping QTLs, MAS for QTL improvement. Regression approach, single marker and multiple marker approach, selection for combining ability through molecular markers. Transgenic varieties. Potential, concerns and relative advantages, bio-safety issues of genetic implications.

Suggested Readings:

- Allard, R.W. 2000. Principles of Plant Breeding. John Wiley and Sons, New York.
- Chopra, V.L. 1989. Plant Breeding (ed.). Oxford and IBH Publishing Co. Pvt., New Delhi.
- Fehr, W.R. 1987. Principles of Cultivar Development (Vol. 2). Mac Millan Publishing Company Inc. New York.
- Hays, H.K., Immer, F.R. and Smith, D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company Inc. New York.
- Jenson, N.F. 1989. Plant Breeding Methodology. John Willey and Sons, New York.
- Roy, D. 2000. Plant Breeding – Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.
- Stoskopt, N.C., Tomes, D.T. and Christie, B.R. 2006. Plant Breeding – Theory and Practice. Scientific Publishers, Jodhpur.

PBG 623 MOLECULAR BREEDING IN CROP IMPROVEMENT 3 (2+1)

Theory:

Application of Plant Genetic Engineering. Transgenic crops – application of recombinant DNA technology – current status and future prospects. Selectable markers and reporter system. Regulation mechanism for genetically modified crops. Biosafety issue of transgenic crops. Molecular Breeding – morphological, biochemical and DNA based markers (RFLP, RAPD, AFLP, SSLP etc.); Mapping populations (F_2s, backcrosses, RILs, NILs and DHs). Molecular mapping and tagging of agronomically important traits. QTLs analysis in crop plants. Marker assisted selection for qualitative and quantitative traits. Gene pyramiding. Advantages and limitations of molecular markers. Recombinant DNA technology. Tissue culture techniques and their scope in crop improvement-cell culture, Organogenesis, somatic embryogenesis. Somatic hybridization, anther culture, embryo culture, meristem culture, clonal propagation, somaclonal and gametoclonal variation.

Practical:

Preparation of plant cell culture, media and autoclaving. Surface sterilization of explants – (i) different concentration of surface sterilant (ii) Sterilization of the explants for variable time period. Callus culture/Induction in economic crops. Regeneration. Anther culture. Isolation and culture of protoplast and its fusion. Demonstration of Isolation of DNA from higher plants, plasmids and bacteriophages, Demonstration and practice of important biotechnological techniques, transformation, isozyme analysis, molecular marker analysis using PCR technique.

Suggested Readings:

- Bhojwani, S.S. and Rajdan, M.K. 1996. Plant Tissue Cultive. Theory and Practice. Revised ed. Elsevier, Amsterdom.
- Brown, T.A. 2001. Gene Cloning and DNA Analysis, - An Introduction. Blackwell Sc. London.
- Caetano – Anolles, G. and Gresshoff, P.M. 1997. DNA Markers: Protocols, Applications and Overview. WILEY-VCH, New York, USA
- Gupta, P.K. 2006. Biotechnology and Genomics. Rastogi Publications. Merrut.
- Liu, Ben Hui. 1998. Stastical Genomics: Linkage, Mapping and QTL Analysis. CRC Press, LLC Florida, USA
- Natesh, S., Chopra, V.L. and Ramchandran, S. (Eds.) 1987. Biotechnology in Agriculture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Primrose, S.B. and Twyman, R.M. 2006. Principles of Gene Manipulation and Genomics. 7th ed. Blackwell Sc. Publishing. London.
- Rajdan, M.K. 1996. An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Winnacker Ernst -L. 2006. From Genes to Clones: Introduction to Gene Technology. VCH Publishers, Weinheim (Germany), Panima Publishing Corporation, New Delhi / Bangalore.

PBG 624 **POPULATION GENETICS** **3(3+0)**

Theory:

Foundation of theoretical population genetics. Hardy-Weinberg Law. Dynamics of gene frequency under selection, migration, mutation and genetic drift. Subdivision – selection in niches, small and pedigreed population. Linkage-equilibrium: two and multi-gene system. Polymorphisms and evolution, Inbreeding. Correlation between relatives. Mixed mating systems. Genetic load and fitness. Co-adapted gene complexes. Homeostasis. Adaptive organization of gene pools. Introgression: case studies to illustrate various concepts of population genetics.

Suggested Readings:

- Falconer,D.S. and Mickey, J. 1996. Introduction to Quantitative Genetics. Longman Group Ltd. London.
- Hartl, D.L. and Clark, A.G. 1989. Principles of Population Genetics. Sinauer Associates, Massachusetts, USA.
- Kempthorne, O. 1957. An Introduction to Genetic Statistics. John Wiley and Sons, New Delhi.
- Li, C.C. 1982. Population Genetics. Iowa State University, USA.
- Roy, D. 2000. Plant Breeding – Analysis and Exploitation of Variation. Narosa Publishing House, New Delhi.

PBG 625 PRINCIPLES OF CYTOGENETICS 3(2+1)

Theory:

History of cytogenetics. Chromosome structure and function in prokaryotes and eukaryotes. Karyotype analysis, chromosome banding pattern and fine structure. Different forms of chromosomes and their functional significance. Lamp brush chromosomes, polytene chromosome, B chromosome, sex chromosomes and artificial chromosomes. Cell division - Mitotic cell cycle, chromosome cycle and chromosome movements, behavior of chromosomes during meiosis and its significance. Mechanism and theories of crossing over. Cytological basis and role of synaptonemal complex. Structural variation in chromosome, their cytological consequences, and uses in cytogenetical studies. Numerical variation in chromosomes, classification, cyto-genetics, segregation, evolutionary significance and use in basic and applied research. Synthesis of natural and new polyploids; barriers in producing synthetic polyploids and means to overcome the nucleocytoplasmic interaction. Elements of molecular cyto-genetics.

Practical:

Preparation of important stains. Microscopy, preparation of slides. Fixing of materials for mitotic and meiotic analysis. Demonstration of chiasmata. Karyotype analysis, chromosomal aberrations. Chromosome banding, Photomicrography.

Suggested Readings:

- Burnham, C.R. 1964. Discussions in Cytogenetics. Burgers Publishing Company, Minnensota U.S.A.
- Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
- Jain, H.K. 1999. Genetics – Principles, Concepts and Implications. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Prasad, G. 1998. Introduction to Cytogenetics. Kalyani Publishers.
- Singh, P. 2001. Elements of Genetics. Kalyani Publishers.
- Swaminathan, M.S., Gupta, P.K. and Sinha, U. 1974. Cytogenetics of Crop Plants. MacMillan, India Ltd., New Delhi.
- Singh, B.D. 2005. Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.
- Strickberger, M.W. 2002. Genetics. Prentice Hall of India Pvt. Ltd, New Delhi.

PBG 626 BREEDING FOR QUALITY AND SPECIAL CHARACTERS 3 (3+0)

Theory:

Concept of nutritional quality. Quality traits in cereals (wheat, rice, maize) millets (bajra, sorghum, small millets), pulses (gram, arhar, urd, mung), oil seeds (rapeseed mustard, groundnut, soybean and sesame) and forage crops (berseem) and fiber crops (cotton). Problems, objectives and prospects. Genetics sources, quality traits and advances in methods of breeding for nutritional quality and special characters. Elimination of toxic substances. Achievements made through breeding for improving nutritional quality. Genetics of biological nitrogen fixation.

Suggested Readings:

- Axtell, J.D.G. Ejeta. 1990. Improving Sorghum Grain Protein Quality by Breeding. In Proceedings of the International Conference on Sorghum Quality. Ed. G. Ejeta. Ed Purdue University, West Lafayetle. PP 117-125.
- Frey, K.J. 1981. Plant Breeding I and II. Kalyani Publisher, New Delhi.
- Ram, H. H. and Singh, H. G. 1994. Crop Breeding and Genetics. Kalyani Publishing, New Delhi.
- Sprague, U.F. and Dubey,J.M. 1998. Corn and Corn Improvement (Ed. Sprague, U.F. and Jiovidudley. Pp. 869-880).
- Singh, B.D. 2005 Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.

PBG 627 BREEDING FOR PULSES AND OILSEEDS 3(3+0)

Theory:

Production and productivity trends of important pulses and oil seeds. Constraints leading to low production and productivity of important pulses and oil seeds. Prospects of increasing production and productivity of pulses and oilseeds. Genetics of yield and yield components in important pulses crop. Genetics of yield and yield components in important oil seed crops. Physiology of yield and quality characters in important pulses and oilseed crops. Current status of improvement - National and regional status of improved cultivars in pulses and oil seeds crops. Germplasm utilization germplasm resources of different pulses and oil seed crops and their utilization in breeding programme. Ideotypes, methods of breeding for yield improvement in important pulses and oil seed crops. Methods of breeding for biotic and abiotic stresses in important pulse (pigion pea, gram, urd/mung) and oilseeds crops (groundnut, soybean, brassicas). All above aspects are to be delt in reference to important pulse (pigion pea, gram, urd/mung) and oilseeds crops (groundnut, soybean, brassicas).

Suggested Readings:

- Bahl. P.N. and Salimath, P.M. 1996, Genetics, Cytogenetics and Breeding of Crop Plants Vol.I and II, Oxford and IBH publishers, New Delhi.
- Ram, H.H. and Singh, H.G. 1994. Crop Breeding and Genetics Kalyani publications, New Delhi.
- Singh, D.P., 1991. Genetics and Breeding of Pulse Crops, Kalyani Publications, New Delhi.
- Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.
- Srivastava, H.C. Bhaskarau, B.V. and Menon, K.K.G. 1984. Oilseed production constraints and opportunities. Oxford and IBH publishing Co. New Delhi.
- Yadav, D.S. 1991. Pulse Crops, Kalyani Publications, New Delhi.

PBG 628 BREEDING FOR VEGETABLES AND FRUITS 3(2+1)

Theory:

Botany and taxonomy, chromosome number, center of origin, species relationship, floral biology, breeding objectives and constraints, disease and pest resistance and quality (physical, chemical, nutritional and marketing) improvement, conventional and non-conventional breeding methods, important varieties, seed production of improved varieties and hybrids and future thrust area in fruits and vegetables like cauliflower, carrot, cucurbits (bottle guard and melon), tomato, chilli, okra, potato, onion, garlic, papaya, ber, aonla,, mango, date palm, citrus, grape and guava.

Practical:

Study of floral biology, hybridization technique. Layout of breeding trials of annuals and perennials. Observation recording, analysis and interpretation of breeding trials. Calculation of variability parameters, repeatability, heterosis and inbreeding depression. Salient features of varieties recommended for the region for the crops viz., cauliflower, carrot, cucurbits, tomato, chilli, okra, potato, onion, garlic, papaya, ber, aonla,, mango, date palm, citrus, grape and guava (available at the time of semester).

Suggested Readings:

- Chaddha, K.L. and Rajendra Gupta. 1995. Advances in Horticulture Vol. II Medicinal and Aromatic Plant. Malhotra Publishing House, New Delhi.
- Joshi and Korla 2001. Vegetable Breeding (A practical guide). Y.S.P. University f Horticulture and Forestry, Solan.
- Katyal and Chadha 1995. Vegetable Growing in India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Kohl, V.K. 2000. Advances in Breeding Vegetable Crops. Central Tuber Crop Research Institute.
- Singh, B.D. 2005. Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.
- Singh, S.P. 2004. Seed Production of Commercial Vegetables. Agrotech Publishing Academy, Udaipur.
- Shukla, A.K. and Shukla, A.K. 2004. Fruit Breeding. IBDC, Lucknow.
- Ram, H.H. 2005. Vegetable Breeding – Principles and Practics. Kalyani Publishers, New Delhi.
- Surendran, C; Sehgal, R.N and Paramathma, M. 2003. Text book of Forest Tree Breeding. ICAR, New Delhi.

PBG 631 HETEROSIS BREEDING 3(2+1)

Theory:

Heterosis - concept and historical background. Genetic structure of population in relation to mode of pollination and mating systems. Inbreeding depression and coefficient of inbreeding. Genetic, physiological and molecular basis of heterosis. Heterosis breeding methodology – development and improvement of heterotic pools, populations and inbred lines. Evaluation of inbred lines and hybrids – nature and number of testers, combining ability and prediction of hybrid performance. Heterosis and genetic diversity, genotype-environment interactions and heterosis.

Male sterility and incompatibility systems – development, maintenance and exploitation in hybrid breeding. Application of biotechnology in heterosis breeding – molecular markers, double haploids, somatic hybridization. Current status and future prospects of hybrid breeding in maize, bajra, cotton, sorghum, wheat, rice castor, mustard, sunflower, pigeon pea and vegetable crops.

Practical:

Estimation of heterosis – test of significance and interpretation. Estimation of inbreeding coefficient. Prediction of double and triple cross performance.

Identification of maintainers and restorers in wheat, rice, sorghum and brassica. Observations on floral traits promoting out crossing. Planning of hybrid seed production programme – isolation requirements, field layout, demonstration of hybrid seed production on public and private farms.

Suggested Readings:

- Banga, S.S. and Banga, S.K. 1998. Hybrid Cultivar Development. Narosa Publishing House, New Delhi.
- Coors, J.G. and Pandey. 1999. Genetics and Exploitation of Heterosis in Crops. American Society of Agronomy, Inc. and Crop Science Society of America, Inc.
- Gowen, J.W. 1952. Heterosis, Iowa State College Press, Ames, Iowa.
- Halluer, A.R. and Miranda, J.B. 1989. Quantitative Genetics in Maize. Iowa State University Press, Ames.
- Mukherji, B.K. 1995. The Heterosis Phenomenon. Kalyani Publishers, New Delhi.
- Rai, M. and Maurya, S. 1995. Hybrid Research and Development. Indian Society of Seed Science and Technology, IARI, New Delhi.

PBG 632 BREEDING FOR BIOTIC AND ABIOTIC STRESSES 3 (2+1)

Theory:

Nomenclature and classification of stresses. Genetic, physiological and molecular mechanisms of disease and insect pest resistance. Host parasite interaction – variation in pathogen and host, factors affecting host reactions, Gene-for-gene concept - implications and significance in plant breeding. Identification of resistance genes. Diversity and characterization of pathogen variation Multipathotype testing. Gene postulation using infection type data. Sources of resistance, shuttle breeding and stability of resistance. Management of gene for resistance, gene deployment over time and space. Mechanism of durable resistance, breeding methods for disease resistance. Concepts of varietal blends, mixtures and multilines for stress resistance.

Breeding for tolerance to abiotic stresses: moisture, salinity, alkalinity, and temperature. Morphological, physiological and genetic basis of abiotic stresses. Transgenics in management of biotic and abiotic stresses.

Practical:

Inoculation, scoring and screening for various parameters of biotic stress in different crop plants. Techniques of building spore inoculums, preparation of spore suspension of different types of pathogens, their application and scoring of disease. Insectory and rearing of insects under laboratory conditions and their release for screening purpose. Screening of soil born and root pathogen for their resistance in sick plots. Screening for drought resistance at germination and seedling establishment stage in different crops. Screening for temperature tolerance. Screening for salinity resistance at germination and seedling establishment stage in different crops. Study of various other parameters imparting resistance to environmental stress under field conditions.

Suggested Readings:

- Blum, A. 1988. Plant Breeding for Stress Environments. CRC Press, Florida.
- Boyer, J.S. 1996. Advances in Drought Tolerance in Plants. *Adv. in agron*, 56: 187-218.
- Chopra, V.L. and Paroda. R.S. 1986. Approaches for Incorporating Drought and Salinity Resistance in Crop Plants. Oxford & IBH Publishing Co., International U.K. London, New Delhi. Press, London.
- Dhaliwal, G.C. and Dilawari. V.K. 1993. Advances in Host Plant Resistance to Insect. Kallyani Publishers, New Delhi.
- Levitt, J. 1980. Responses of Plant to Environmental Stress\. Academic.
- Panda, N. and Khus. G.S. 1995. Host Plant Resistance to Insects. CAB.
- Russel, G.E. 1981. Plant Breeding for Plant Pest and Disease Resistance. Bullerworths. London.
- Shannon, M.C. 1998. Adaptation of plants to salinity. *Adv. in Agron*, 60:76-120.
- Sharma, J.R. 1994. Principles and Practices of Plant Breeding. Tata McGraw Hill Publishing Company Ltd., New Delhi.
- Singh, K.N. 1995. Recent approaches to breeding for salt tolerance in crop plants. In: Proc. Genetic Research and Education: Current Trends & the Next Fifty Years. (Eds. B. Sharma et al.) Vol. I. Indian Society of Genetics and Plant Breeding, New Delhi: 490-499.

❖ Singh, B.D. 2005 Plant Breeding – Principles and Methods. Kalyani Publishers, New Delhi.

PBG 633 MUTAGENESIS 3(2+1)

Theory:

Nature and Scope of mutagenesis. Types of mutations. Mode of Induction of mutations. Physical mutagens-types, effect and mechanism, chemical mutagens-types, effect and mechanism. Somaclonal variation. Repair of genetic damage. Genetic sieves in induced mutations, test systems. Modifying testers. Biological and environmental parameters influencing mutagenic efficiency. Application methodology of mutagens and modification of their action. Mutagenic specificity and directed mutagenesis. Targeted gene replacement, gene silencing. Mutation breeding in plants, animals and micro-organisms. Use of mutagens as carcinostatic agents. Environmental mutagenesis – bacteria, mammalian cell cultures, Drosophila, transgenics as environmental mutagen monitors.

Practical:

Preparation of mutagen solution at different pH and their effect. Determination of LD_{50} of different mutagens. Study of cytomorphological effect of various physical and chemical mutagens. Mutation analysis (antibiotic resistance) in Bacteria. Study of effect of UV rays on Pollen grains: M_1 and M_2 analysis.

Suggested Readings:

❖ Auerbach, C. 1976. Mutation Research, Problems, Results and Perspective. Chapman and Hall, London.
❖ Drake, J.W. land Koch, R.E., 1976. Mutagenesis. Dowden Hutchinson and Ross, Inc., USA.
❖ IAEA. 1991. Plant Mutation. Breeding for crop Improvement. Proc. FAO/IAEA symposium (Vol. 1 & 2). IAEA, Vienna.
❖ IAEA, 1995. Induced Mutations and Molecular Techniques for crop improvement Proc. FAO/IAEA Symposium, Vienna.
❖ Micka, A. 1991. Induced Mutations for crop improvement. Gamma Field Symposia No. 30. Institute of Radiation Breeding, Pullman, U.S.A.
❖ Siddiqui, B.A. and Khan, S. 1999. Breeding in Crop plants – Mutations & In virto Mutation Breeding. Kalyani Publishers, New Delhi.

PBG 634 APPLIED CROP CYTOGENETICS AND GENOME ANALYSIS 3(2+1)

Theory:

Application of cytogenetical methods for plant improvement. Location and mapping of genes on chromosomes by various methods viz., induced deficiency, use of trisomics and monosomics. Identification of chromosomes involved in interchange, genetic consequences, balance lethal systems, its maintenance and utility. Location of genes on the chromosome by inversion and trisomics. Balance tertiary trisomics, its use in hybrid seed production. Monosomics – method of production. Substitution and addition lines for transfer of alien genes. Autopolyploids for crop improvement. Distant hybridization: scope and limitations.

Principles and procedures of genome analysis. Co-linearity among genomes and synteny. Cytogenetic techniques at molecular level and chromosome engineering in plants. Isolation mechanisms and criterion of species. Cytogenetic study of evolution and centers of diversity of major crops like wheat, triticale, rice, maize, sugarcane, brassica, cotton, tobacco, potato, forage crops and cucurbits.

Practical:

Genome analysis based on morphological traits. Chromosome pairing in inter-generic and inter-specific crosses. Maintenance of aneuploid stocks and location of genes on specific chromosomes. Chromosome pairing and chiasma frequency in monosomic, trisomic, nullisomics. Pachytene, analysis of pairing in wheat and rye hybrids.

Suggested Readings:

- Gupta, P.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
- Jauhar, Prem P. 1996. Methods of Genome Analysis in Plants. CRC Press, Canada.
- Khush, G.S. 1973. Cytogenetics of Aneuploids. Academic Press, New York & London.
- Primrose, S.B. & Twyman R.M. 2003. Principles of Genome Analysis & Genomics. Blackwell Publishing, Italy.
- Swaminathan, M.S., Gupta, P.K. and Sinha, U. 1974. Cytogenetics of Crop Plants. MacMillan, India Ltd.; New Delhi.

PBG 635 BREEDING FOR CEREALS & MILLETS 3(3+0)

Theory:

Production and productivity trends – constraints for low production and productivity and measures to overcome. Breeding objectives, genetics of yield, yield components, biotic and abiotic stresses. Selection criterion for higher yield, plant types for attaining higher yields. Advances in breeding methodology. Current status of improvement – major breeding achievements, Germplasm resources – utilization and genetic diversity. All above aspects are to be dealt in reference to important crops viz. wheat, rice, maize, pearlmillet and sorghum.

Suggested Readings:

- Anonymous. 1985. Rice Genetics. IRRF, Mancla Co. Inc. Westport Connecticut. USA.
- Bahl. P.N, and Salimath, P.M. 1996. Genetics, Cytogenetics and Breeding of Crop Plants (Vol. I and II). Oxford and IBH Publishers, New Delhi.
- House, L.R., Mughogho, L.K. and Peacock, J.M. 1982. Sorghum in Eighties Vol. I and II, ICRISAT, Patancheru, (A.P.).
- Poelhman, J.M. 1987. Breeding of Field Crops (3rd ed.). AVI Pub. Co. INC. West Port, Connecticut, USA.
- Ram, H.H. and Singh, H.G. 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.
- Sarkar, K.R., Singh, N.N. and Sachan, J.K. 1991. Maize Genetics Perspectives. Indian Society of Genetics and Plant Breeding, New Delhi.
- Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.
- Ram, H. H. 2005. Vegetable Breeding – Principles and Practices. Kalyani Publishers, New Delhi.

PBG 636# **MOLECULAR GENETICS** **3 (3+0)**

Theory:

Genomes in prokaryotes and eukaryotes, Genome organization– euchromatin and heterochromatin, DNA content variation. Mutagenesis at molecular level. Types of DNA sequences-unique & repetitive, VNTRs, Mini satellites and micro-satellites, DNA organization in eukaryotic chromosomes. Organelle genomes, Gene amplification and its significance, Mechanisms of DNA replication & recombination in prokaryotes and eukaryotes, DNA sequencing, Gene fine structure in prokaryotes & eukaryotes, Split genes, Alternative splicing, trans splicing, pseudogenes, overlapping genes and nested genes, Transcription and its regulation-mechanisms in prokaryotes and eukaryotes, Enhancers, suppressors, transcriptomes, transcription factors and their role, Post-transcriptional regulation mRNA processing, SnRNAs, ribosomes and RNA editing, Regulation of protein synthesis in prokaryotes and eukaryotes, ribosomes, tRNAs and translational factors, Post translational modification, Structural and functional genomics.

Molecular mapping and tagging of genes. Marker assisted selection. Proteomes and protein-protein interactions, Signal transduction, Genes and development, Mechanisms and regulation of cell division, Cancer and cell ageing.

Suggested Readings:

- Brown, T.A. 1998. Genomes. John Wiley and Sons (East Asia), Singapore.
- Freifelder, D. 2004. Molecular Biology, Narosa Publishing House, New Delhi.
- Gardner, E.J., Simmons M.J. and Peter Snouted, D. 1995. Principles of Genetics John Wiley and Sons, New York.
- Karp, G. 2002. Cell and Molecular Biology, John Wiley & Sons, Inc. VAN Hoffman Press, Newyork.
- Lewin, B. 2005. Genes VII. Oxford University Press, New York.
- Primrose, S.B. and Twyman, R.M. 2003. Principle of Genome Analysis and Genomics. Blackwell Publishing, Italy.
- Primrose, S.B., Twyman, R.M. and Old R.W. 2004. Principle of Gene Manipulation. Blackwell Publishing, Italy.
- Primrose, S.B. and Twyman, R.M. 2006. Principle of Gene Manipulation and Genomics Blackwell Publishing, Italy

Core Course

PBG 637 IMPROVEMENT OF FIELD CROPS 3 (2+1)

Theory:

Eminent Plant Breeders and their achievements; Breeding methods of specific crop like cereals (wheat, rice, maize, sorghum and millets); pulses (gram, pea, pigeon pea, mungbean); oilseeds (Brassica, soybean, groundnut), fibre crops (cotton); forage crops (berseem) and asexually propagated crops; (Sugarcane & potato). National and International Institutes for crop improvement.

Practical:

Exposure of students to on-going breeding work of important crops. Collection and analysis of data on field trails.

Suggested Readings:

- Fehr, W.R. 1987. Principles of cultivars Development (Vol. 1). Mac Milan Publishing Company Inc. New York.
- Manjit S. Kang 2004. Crop Improvement: Challenges in the Twenti-First Century (Edt). Internatinal Book Distributing Co.Lucknow.
- Poehlman, J.M. 1987. Breeding Field Crops. AVI Publishing Company Connecticut.
- Poehlman, J.M. and Borthakur, D.N. Breeding Asian Field Crops 1977. Oxford and IBH Publishing Co., New Delhi.
- Ram, H.H. 2005. Vegetable Breeding – Principles and Practices. Kalyani Publishers, New Delhi.
- Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.

PBG 638 BREEDING FOR FIBRE, FORAGE, SEED SPICES AND VEGETATIVELY PROPAGATED CROPS 3(3+0)

Theory:

Production, productivity, constraints and prospects of fibre, forage and asexually propagated crops. Genetics and physiology of yield and quality traits of fibre, forage, Spices and asexually propagated crops. Current status of improvement of these crops. Germplasm utilization. Methods of breeding for yield. Methods of breeding for biotic and abiotic stresses. Crops include : Fibre : Cotton, Forage : Perrimal grass and berseem, Spices : Fenugreek, coriander and cumine, Vegetatively Propogated Crops : Sugarcane, potato.

Suggested Readings:

- Bahl, P.N. and P.M. Salimath. 1996. Genetics, Cytogenetics and Breeding of Crop Plants (Vol. I & II). Oxford and IBH Publishers. New Delhi.
- Poelhman, J.M. 1987. Breeding of Field Crops (3rd ed.) AVI Pub. Co. INC. West port. Connecticut, USA.
- Ram, H.H. and Singh, H.G. 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.

PBG 639 FUNDAMENTALS OF GENETICS AND PLANT BREEDING 3 (2+1)

Theory :

Historical perspective on Genetics, Cell division. Mendelian principles; Gene interactions; Linkage: detection and estimation. Inter-genic and intra-genic complementation. Genetic material : fine structure of gene, replication and chromosome organization. Genetic code, transcription and translation. Environmental influence on gene expression. Extra nuclear inheritance. Polygenic inheritance. Hardy-Weinberg equilibrium, changes in gene and genotype frequencies. Expectation of fixed and random effect models. Covariance between relatives. Heritability, selection differential, response to selection and correlated response. Concept of combining ability and its relevance to gene action. Inbreeding and heterosis – simple model, extension to polygenic situations. Mating designs – Diallel, North Carolina, Line x Tester and Triple test cross. Generation mean analysis. Genotype x environment interaction and stability analysis. Various parameters of variability, correlation, path coefficient, etc.

Plant breeding – history and objectives, germplasm collection, evaluation and conservation, center of origin. Mechanisms controlling pollination and their consequences, male sterility and self incompatibility. Breeding self pollinated crops – methods, their basis and achievements. Pure line theory and concept of pure line. Heterosis and theories. Population and role of population, intra and their population improvement methods and achievements. Synthetic, composite and multiline varieties. Clonal selection. Mutation and polyploidy breeding – methods, uses, mechanisms. Classes of seed, principles of seed production, maintenance and standards. Seeds certification, processing, storage and legislations. IPR issues. Important varieties of crop plants and procedure of release of new varieties. Breeding for biotic, abiotic stresses, ideotype and quality parameters.

Application of plant genetic engineering and biotechnology, tissue culture technology, gene cloning. Restriction enzymes and vectors. Gene transfer systems-vector mediated and direct gene transfer techniques. Molecular breeding - morphological, biochemical and DNA based markers. QTLs analysis in crop plants. Marker assisted selection and their scope in crop improvement. Biosafety issues of transgenic crops.

Practical:

Floral biology, emasculation and pollination in important crop species. Pollen viability and measurement of pollen size Variability parameters, their estimation and interpretation. Genotypic and phenotypic correlations, their estimation and interpretation. Testing of genetical results (x^2 test)

Suggested Readings:

- Allard, R.W. 2000. Principles of Plant Breeding. John Wiley and Sons. New York.
- Singh, B.D. 2001. Fundamental of Genetics. Kalyani Publishers, New Delhi.
- Singh, B.D. 2005. Plant Breeding. Principles and Methods. Kalyani Publishers, New Delhi.
- Sharma, J.R. 1994. Principles and Practices of Plant Breeding. Tata MCGraw Hill Publishing Company Ltd. New Delhi.