SYLLABUS

For

B.Sc. (Honours) Agriculture

2018-19

FACULTY OF AGRICULTURE
AGRICULTURE UNIVERSITY, KOTA

Syllabus for B.Sc. (Honours) Agriculture

Agricultural Economics - Annexures-I (1) to (I) (4)

1.	AGECON-121	Fundamentals of Agricultural Economics	2(2+0)
2	AGECON-211	Agricultural Finance and Co-Operation	3(2+1)
3.	AGECON-221	Agricultural Marketing, Trade & Prices	3(2+1)
4	AGECON-321	Farm Management, Production & Resource Economics	2(1+1)

AGRICULTURAL ECONOMICS

AGECON-121	**Fundamentals of Agricultural Economics**	**2(2+0)**

Theory

Economics: Meaning, scope and subject matter, definitions, activities, approaches to economic analysis; micro and macro economics, positive and normative analysis. Nature of economic theory; rationality assumption, concept of equilibrium. Basic concepts: Goods and services, desire, want, demand, utility, cost and price, wealth, capital, income and welfare. Agricultural economics: meaning, definition, characteristics of agriculture, importance and its role in economic development. *Demand:* meaning, law of demand, demand schedule and demand curve, determinants, utility theory; law of diminishing marginal utility, equi-marginal utility principle. Consumer's equilibrium, concept of consumer surplus. Elasticity of demand: concept and measurement of price elasticity, income elasticity and cross elasticity. Production: process, creation of utility, factors of production, input output relationship. *Laws of returns*: Law of variable proportions and law of returns to scale. *Cost:* Cost concepts, short run and long run cost curves. Supply: Stock v/s supply, law of supply, supply schedule, supply curve, determinants of supply, elasticity of supply. Market structure: meaning and types of market, basic features of perfectly competitive markets. Price determination under perfect competition in short run. Distribution theory: meaning, factor market and pricing of factors of production. Concepts of rent, wage, interest and profit. *National income:* Meaning and importance, concepts of national income accounting and approaches to measurement. Population: Importance, Malthusian population theory, current policies and programmes on population control. Money meaning and functions of money, general price index, inflation and deflation. Banking: types of banks, functions of commercial Bank. *Tax:* meaning, direct and indirect taxes, agricultural taxation, VAT & GST. *Economic systems:* meaning of capitalistic, socialistic and mixed economies.

References:

1. K.K. Dewett and J.D. Verma (1986) Elementary Economic Theory, S. Chand & Company, New Delhi
2. S.K. Mishra and V.K. Puri (1996) Indian Economy, Himalaya Publishing House, New Delhi
3. G.B. Jakhar and S.G. Beri (1996) Elementary Principles of Economics, Oxford University Press (10th Edition), Delhi
4. Berkeley Hill (1980) An Introduction to Economics for students of agriculture, Pergaman Press, Oxford
5. B.L. Gupta (1996) Introduction to Economic Theory, Arya Book Depot, New Delhi

AGECON-211	Agricultural Finance and Co-Operation	3(2+1)

Theory

Agricultural Finance- meaning, scope and significance, credit needs and its role in Indian agriculture. Agricultural credit: meaning, definition, need, classification. Credit analysis: 4 R's, and 3C's of credits. Sources of agricultural finance: institutional and non-institutional sources, commercial banks, social control and nationalization of commercial banks, Micro financing including KCC. Lead bank scheme, RRBs, Scale of finance and unit cost. An introduction to higher financing institutions – RBI, NABARD, ADB, IMF, world bank, Insurance and Credit Guarantee Corporation of India. Cost of credit. Preparation and analysis of financial statements – Balance Sheet and Income Statement. Basic guidelines for preparation of project reports

Agricultural Cooperation – Meaning, brief history of cooperative development in India, objectives, principles of cooperation, significance of cooperatives in Indian agriculture. Agricultural Cooperation in India- credit, marketing, consumer and multi-purpose cooperatives, farmers' service cooperative societies, processing cooperatives, farming cooperatives, cooperative warehousing; role of NAFED.

Practicals

Optimum allocation of limited amount of capital among different enterprise. Analysis of progress and performance of cooperatives using published data. Analysis of progress and performance of commercial banks and RRBs using published data. Visit to a commercial bank, cooperative bank and cooperative society to acquire firsthand knowledge of their management, schemes and procedures. Estimation of credit requirement of farm business – A case study. Preparation and analysis of balance sheet – A case study. Preparation and analysis of income statement – A case study. Appraisal of a loan proposal – A case study. Techno-economic parameters for preparation of projects.

References:

1. Reddy, S. and Raghu Ram, P. "Agricultural Finance and Managament" Oxford and IBH, New Delhi
2. Singh, J.P. (1990) "Agricultural Finance- Theory and Practice" Ashish Publishing House, New Delhi
3. Pandey, U.K. "An Introduction to Agricultural Finance" Kalyani Publishes, New Delhi
4. Pandey, Mukesh and Tewari, Deepali "Rural and Agriculture Marketing"
5. Mamoria, C.B. "Agricultural Problems of India"
6. Krishnaswami, O.R. "Fundamental of Cooperation"
7. Nelson, A.G. and Murray, W.G. 1988 "Agricultural Finance" IOWA State University Press, Amies, IOWA, USA
8. Johl, S.S. : Essentials of Farm Financial Management, Atlas Books and Periodicals (TTPP)

AGECON-221	Agricultural Marketing, Trade & Prices	3(2+1)

Theory

Agricultural Marketing: Concepts and definitions of market, marketing, agricultural marketing, market structure, marketing mix and market segmentation, classification and characteristics of agricultural markets**;** demand, supply and producer's surplus of agri-commodities: nature and determinants of demand and supply of farm products, producer's surplus – meaning and its types, marketable and marketed surplus, factors affecting marketable surplus of agri-commodities; product life cycle (PLC) Meaning and stages in PLC; characteristics of PLC; strategies in different stages of PLC. Market promotion – advertising, personal selling, sales promotion and publicity – their meaning and merits & demerits; marketing process and functions: exchange functions – buying and selling; physical functions – storage, transport and processing; facilitating functions – packaging, branding, grading, quality control and labeling (Agmark);Market functionaries and marketing channels: Types and importance of agencies involved in agricultural marketing; meaning and definition of marketing channel; marketing channels for different farm products; Integration, efficiency, costs and price spread: Meaning, definition and types of market integration; marketing efficiency; marketing costs, margins and price spread; factors affecting cost of marketing; reasons for higher marketing costs of farm commodities; ways of reducing marketing costs; Role of Govt. in agricultural marketing. Introduction to CWC, SWC, FCI, CACP & DMI. Cooperative marketing in India; Risk in marketing: Types of risk in marketing; speculation & hedging; an overview of futures trading; Agricultural prices and policy: Meaning and functions of price; administered prices; need for agricultural price policy; Trade: Concept of International Trade and its need, theories of absolute and comparative advantage. GATT and WTO; Agreement on Agriculture (AoA) and its implications on Indian agriculture; IPR.

Practical

Plotting and study of demand and supply curves and calculation of elasticities**;** Study of relationship between market arrivals and prices of some selected commodities; Computation of marketable and marketed surplus of important commodities; Study of price behaviour over time for some selected commodities; Construction of index numbers; Visit to a local market to study various marketing functions performed by different agencies, identification of marketing channels for selected commodity, collection of data regarding marketing costs, margins and price spread and presentation of report in the class; Visit/assignment to market institutions – NAFED, SWC, CWC, cooperative marketing society etc. to study their organization and functioning.

References:

1. Acharya SS & Aggarwal NL. (2011) Agricultural Marketing in India, Oxford and IBH
2. J.R. Moore, S.S. Johl and A.M. Khusro (1973) Indian Food Grain Marketing, Printice Hall.
3. A.S. Kahlon & D.S. Tyagi (1983) Agricultural Price Policyin India, Allied Publishers, New Delhi
4. V.K. Bhall and S. Shiva Ramu (1996) International Business-Environment and Management, Anmol Publications (P) Limited, New Delhi
5. Chandra P. (1984) Projects: Preparation, Appraisal & Implementation, McGraw Hill Inc.
6. Sampat Mukherjee (2002) Modern Economic Theory. New Age International
7. Gupta RD & Lekhi RK. (1982) Elementary Economic Theory, Kalyani Publishers
8. S.S.Acharya & N.L.Agarwal,: Agricultural prices-Analysis and Policy, Oxford &IBH Publishing Co. PVT. LTD. New Delhi

AGECON-321	Farm Management, Production & Resource Economics	2(1+1)

Theory

Meaning and concept of farm management, objectives and relationship with other sciences. Meaning and definition of farms, its types and characteristics, factor determining types and size of farms.Principles of farm management: concept of production function and its type, use of production function in decision-making on a farm, factor-product, factor-factor and product-product relationship, law of equi-marginal/or principles of opportunity cost and law of comparative advantage. Meaning and concept of cost, types of costs and their interrelationship, importance of cost in managing farm business and estimation of gross farm income, net farm income, family labor income and farm business income. Farm business analysis: meaning and concept of farm income and profitability, technical and economic efficiency measures in crop and livestock enterprises. Importance of farm records and accounts in managing a farm, various types of farm records needed to maintain on farm, farm inventory, balance sheet, profit and loss accounts. Meaning and importance of farm planning and budgeting, partial and complete budgeting, steps in farm planning and budgeting. Introduction to linear programming. Concept of risk and uncertainty in agriculture production, nature and sources of risks Crop/livestock/machinery insurance – weather based crop insurance, features, determinants of compensation. Concepts of resource economics, types of natural resources, differences between NRE and agricultural economics, unique properties of natural resources. Positive and negative externalities in agriculture, solutions, Important issues in economics and management of common property resources of land, water, pasture and forest resources etc.

Practical

Preparation of farm layout. Determination of cost of fencing of a farm. Computation of depreciation cost of farm assets. Application of equi-marginal returns/opportunity cost principle in allocation of farm resources. Determination of most profitable level of inputs use in a farm production process. Determination of least cost combination of inputs. Selection of most profitable enterprise combination. Application of cost principles including CACP concepts in the estimation of cost of crop and livestock enterprises. Preparation of farm plan and budget, farm records and accounts and profit & loss accounts. Collection and analysis of data on various resources in Rajasthan.

References:

1. Mittal, S.K. and Sethi, C.P. "Linear Programming."
2. Tandan, R.K. and Dhondiyal, S.P. "Principles and Methods of Farm Management".
3. Heady, E.O. and Candler, W. "Linear Programming Methods."
4. Johl, S.S. and Kapoor, T.R. "Fundamental of Farm Business Management, Kalyani Publishers, Ludhiana and New Delhi
5. Sankhayan, P.L "Introduction to the Economics of Agricultural Production."
6. Singh, I.J. "Elements of Farm Management"
7. Dorfman, R. and Samuelson and Solow, R. "Linear Programming and Economic Analysis."
8. Heady, E.O. and Dillors, J.L."Agricultural Production Function".
9. Karam, A.S. and Karan Singh "Economics of Farm Management in India".
10. M.E. Sharpe and Armonk, N.Y.: Environmental and Natural Resource Economics: Theory, Policy and the Sustainable Society
11. Hartieick, J.M. and Olewiler, N.D.: The Economics of Natural Resource Use

1	AGENGG-121	Introductory Soil and Water Conservation Engineering	2(1+1)
2.	AGENGG-211	Farm Machinery and Power	2(1+1)
3	AGENGG-221	Renewable Energy and Green Technology	2(1+1)
4.	AGENGG-321	Protected Cultivation and Secondary Agriculture	2(1+1)

AGRICULTURAL ENGINEERING

AGENGG-121	**Introductory Soil and Water Conservation Engineering**	**2(1+1)**

Theory

Introduction to Soil and Water Conservation, causes of soil erosion. Definition and agents of soil erosion, water erosion: Forms of water erosion. Gully classification and control measures. Soil loss estimation by universal Soil Loss Equation. Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways. Water harvesting and its techniques. Wind erosion - principle of wind erosion control and its control measures. Familiarization with centrifugal pumps, measurement of irrigation water, water conveyance system and familiarization with pressurized irrigation methods.

Practical

General status of soil conservation in India and Rajasthan. Calculation of erosion index. Estimation of soil loss. Measurement of soil loss. Preparation of contour maps. Design of contour bunds. Design of graded bunds. Problem on wind erosion. Numerical problems on friction head, velocity head, total head and horse power calculation of pumps. Measurement of irrigation water in the field by different methods and related numerical. Study of components of drip and sprinkler system. Study of watershed area.

Lecture schedule : Theory

S.No.	Topic	No. of lecture
1.	Introduction to Soil and Water Conservation and causes of soil erosion	1
2.	Definition and agents of soil erosion and water erosion	1
3.	Forms of soil erosion-rain drop, sheet, rill and gully erosion: factor affecting soil erosion.	1
4.	Gully classification and control measures.	1
4.	Soil loss estimation by universal Soil Loss Equation.	1
5.	Principles of erosion control: Introduction to contouring, strip cropping. Contour bund. Graded bund and bench terracing. Grassed water ways.	2
6.	Water harvesting and its techniques.	1
7.	Wind erosion- principle of wind erosion and its control measures	1
8.	Centrifugal pumps- volute and diffuser types; Principle of operation of centrifugal pumps.	1

9.	Pump related terms- capacity, suction lifts, suction heads, discharge heads, friction head, pressure head, total head, velocity head, net positive suction head, maximum practical suction lift of pumps, water horsepower, shaft horse power, pump efficiency, brake horsepower.	2
10.	Measurement of irrigation water- volume method, velocity- area methods, water meter, weirs- rectangular, cipolletti, 90^{o} v- notch.	2
11.	Drip irrigation method- Adoptability, limitation, components and layout.	1
12.	Sprinkler irrigation method- adoptability, limitations, types, components and layout.	1

Practical schedule

S.No	Topic	No. of lecture
1	General status of soil conservation in India and Rajasthan	1
2	Calculation of erosion index	1
3	Estimation of soil loss.	2
4	Preparation of contour maps	2
5	Numericals on design of contour bunds	2
6	Numerical problems on friction head, velocity head, total head and horse power calculation of pumps.	2
7	Measurement of irrigation water in the field by different methods and related numericals.	2
8	Study of different components of drip irrigation system	1
9	Study of different components of sprinkler irrigation system	1
10	Visit to nearby watersheds	2

References:

1. Land and Water Management Engineering. 1982. Murthy V.V.N. Kalyani Pubhliers, New Delhi.
2. Irrigation: Theory and Practices.2012. Michael A.M. Vikas Publishing House Pvt. Ltd., New Delhi.
3. Principles of Agricultural. Engineering. Vol. II. 2012. Michael A.M. and T.P. Ojha. Jain Brothers, New Delhi.
4. Soil and Water Conservation Water Management. 2010. Mahnot, S.C., Singh P.K. and Chaplot, P.C.,. Apex Publication House, Udaipur.

AGENGG-211	Farm Machinery and Power	2(1+1)

Theory

Status of Farm Power in India, Sources of Farm Power , I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines , Study of different components of I.C. engine, I.C. engine terminology and numerical, Familiarization with different systems of I.C. engines: Air cleaning, cooling, lubrication ,fuel supply and hydraulic control system of a tractor, Familiarization with Power transmission system : clutch, gear box, differential and final drive of a tractor , Tractor types, Cost analysis of tractor power, Estimation of field capacity and power requirements of implements Familiarization with Primary and Secondary Tillage implement, implement for intercultural operations, Familiarization with sowing and planting equipment, Familiarization with Plant Protection equipment, Familiarization with harvesting and threshing equipment.

Practicals

Study of different components of I.C. engine. To study air cleaning and cooling system of engine, Familiarization with clutch, transmission, differential and final drive of a tractor, Familiarization with lubrication and fuel supply system of engine, Familiarization with brake, steering, hydraulic control system of engine, Learning of tractor driving, Familiarization with operation of power tiller, Familiarization with different types of primary and secondary tillage implements: mould board plough, disc plough and disc harrow . Familiarization with seed metering mechanism and calibration of seed drill, Familiarization with different types of sprayers and dusters Familiarization with different inter-culture implement, Familiarization with harvesting and threshing equipments and machinery.

Lecture schedule : Theory

S.No.	Topic	No. of lectures
1.	Sources of farm power and its status in India and Rajasthan.	1
2.	I.C. engines, working principles of I C engines, comparison of two stroke and four stroke cycle engines	1
3.	Study of different components of I.C. engine, I.C. engine terminology and numerical.	2
4.	Air supply and exhaust system- Pre cleaners, oil soaked element type and oil bath type air cleaners; Fuel supply system	1
5.	Lubricating system- splash system and forced feed system; Cooling system-thermosiphon system and forced circulation system	1
6.	Transmission system- clutch, gear box, differential, final drive, P.T.O. shaft and hydraulic control system	1
7.	Tractor types, Estimation of operational cost of a tractor .	1
8.	Familiarization with Primary and Secondary Tillage implement	2

9.	Numerical on field capacity and power requirement of implements	2
10.	Familiarization with implement with intercultural operations	1
11	Familiarization with sowing and planting equipment,	1
12	Familiarization with Plant Protection equipment	1
13	Familiarization with harvesting and threshing equipment	1

Practical schedule:

S.No.	Topic	No. of lectures
1	Study of different components of I.C. engine.	1
2	To study air cleaning and cooling system of engine,	1
3	Study of transmission system.	1
4	Study of transmission system-clutch, gear box, differential, final drive and P.T.O.	1
5	Familiarization with brake, steering, hydraulic control system of engine,	1
6	Tractor driving	3
7	Daily and periodic maintenance of tractor	1
8	Study of power tiller and garden tractor	1
9	Study of primary and secondary tillage implements: mould board plough, disc plough	1
10	Study of secondary tillage implements- cultivators, harrows and hoes	1
11	Study of seed metering mechanism and calibration of seed drill and numericals	2
12	Study of different types of sprayers and dusters	1
13	Study of harvesting machinery - reaper and thresher	3

Suggested Readings:

1. Principles of Agricultural Engineering. Vol. I. 2012. Michael, A.M. and T.P. Ojha. Jain Brothers, Jodhpur.
2. Farm Tractors, Maintenance and Repair.1989. Rai and Jain. Tata Mc Graw Hill Publ. New Delhi.
3. Elements of Farm Machinery.1989. Srivastava, A.C. Oxford IBH Publ. Company, New Delhi.

4. Elements of Agricultural Engineering, Vol. I & III. 1989. Singhal, O.P. Suraj Prakashan, Allahabad.
5. Element of Agricultural Engineering. 1990. Sahay, Jagdishwar. Agro. Book Agency, New Chitragupta Nagar, Patna.

AGENGG-221	Renewable Energy and Green Technology	2(1+1)

Theory

Classification of energy sources, contribution of these of sources in agricultural sector, Familiarization with biomass utilization for bio-fuel production and their application, Familiarization with different types of biogas plants and gasifiers, bio-alcohol, biodiesel. Familiarization with briquetting techniques, Introduction of solar energy, solar collectors and their application, Familiarization with solar energy gadgets: solar cooker, solar water heater, application of solar energy: solar drying, solar distillation, solar photovoltaic system and their application, introduction of wind energy and their application.

Practical

Familiarization with renewable energy gadgets. To study biogas plants, To study gasifier, To study briquetting machine, Familiarization with different solar energy gadgets. To study solar photovoltaic system: solar light, solar pumping, solar fencing. To study solar cooker, To study solar dryers. To study solar distillation system.

Lecture schedule : Theory

S.No	Topic	No. of lecture
1.	Classification of energy sources, contribution of these of sources in agricultural sector.	1
2.	Familiarization with biomass utilization for biofuel production and their application	2
3.	Familiarization with different types of biogas plants.	2
4.	Biogas production techniques and various uses of biogases.	2
5.	Biomass gasification and familiarization with different gasifiers	2
6	Concept of briquetting and familiarization with briquetting machines	1
7	Introduction of solar energy, solar collectors and their application	2
8	Solar thermal applications in different gadgets	2
9	Solar photovoltaic techniques and applications.	1
10	Introduction of wind energy and their application	1

Practical schedule:

S.No	Topic	No. of lecture
1	Study of fixed dom and floating drum type biogas plants	2
2	Study of cross draft, updraft and down draft gasifiers	2
3	To study briquetting machine	1
4	Study of box type solar cooker	1
5	Study of solar water heating system	1
6	Study of solar distillation system	1
7	Study of solar dryer	2
8	Study of solar animal concentrate cooker	1
9	Study of solar photovoltaic water pumping system and visit to nearby solar photovoltaic water pumping system	2
10	Study of solar photovoltaic sprayer	1
11	Study of wind mill	1
12	Study of improved cook stove	1

Suggested Readings:

1. G.D. Rai. Non-Conventional Energy Sources, Kh Publishers, New Delhi.
2. N. S. Rathore. A.K. Kurchania, N.L. Panwar. (2007). Non Conventional Energy Sources, Himanshu Publications.
3. N.S. Rathore. A. K. Kurchania, N.L. Panwar. (2007). Renewable Energy, Theory and Practice, Himanshu Publications.
4. K.C. Khandelwal. & S.S. Mandi. (1990). Biogas Technology.

AGENGG-321	Protected Cultivation and Secondary Agriculture	2(1+1)

Theory

Green house technology: Introduction, Types of Green Houses; climate control in Green house, Planning and design of greenhouses, Design criteria of green house for cooling and heating purposes. Green house equipments, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses naturally ventilated solar green house, high tech green house, use of green house in drying. Concept and construction of low tunnels. Use of shade net house in protected cultivation.

Important Engineering properties such as physical, thermal and aero & hydrodynamic of cereals, pulses and oilseed. Concepts of cleaning and grading. Drying and dehydration: Moisture measurement, EMC, drying theory, various drying methods, commercial grain dryers (bin dryer,

tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer). Material handling equipment: conveyer and elevators, their principle, working and selection.

Practical

Study of different types of green houses based on shape. Measurement of solar radiation, CO_2 level, humidity and temperature inside and outside green house. Determination of drying rate of agricultural products inside green house. Study of green house equipments. Visit to various Post Harvest Laboratories. Determination of Moisture content of various grains by oven drying method. Study of spiral, centrifugal and disc separator. Determination of Moisture content of various grains by moisture meter. Field visit to seed processing plant and agro processing plant.

Lecture schedule : Theory

S.No	Topic	No. of lecture
1.	Introduction to Green house technology, types of green houses and climate control inside green house.	1
2.	Planning and design of greenhouses.	1
3.	Design criteria of green house for cooling and heating purposes and green house equipments	1
4	Materials of construction for traditional and low cost green houses	1
5	Irrigation systems used in greenhouses	1
6	Naturally ventilated solar green house, high tech green house	1
7	Use of green house in drying	1
8	Concept and construction of low tunnels. Use of shade net house in protected cultivation	2
9	Important Engineering properties such as physical, thermal and aero & hydrodynamic of cereals, pulses and oilseed	1
10	Concepts of cleaning and grading vibratory and rotary type air cleaner	1
11	Drying and dehydration: Moisture measurement, EMC, drying theory, various drying methods.	1
12	Commercial grain dryers (bin dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer).	2
13	Material handling equipment: conveyers and elevators, their principle, working and selection.	2

Practical schedule:

S.No.	Topic	No. of lecture
1	Study of various shapes of green houses.	1
2	Measurement of climatic factors inside and outside green houses and study of green house equipments.	1
3	Construct of low tunnel in vegetable crops.	2
4	Study of Shade net house and visit to nearby shade net house	2
5	Drying of agriculture produce in green house	1
6	Determination of moisture content by oven drying methods.	1
7	Study of spiral, centrifugal and disc separator.	1
8	Determination of Moisture content of various grains by moisture meter.	2
9	Study of mechanical grain dryer- bin dryer, tray dryer, and re-circulatory dryer	2
10	Visit to seed processing plant	1
11	Visit to agro processing plants	2

Suggested Readings:

1. Green house: Science and Technology. 2016. Kothari S, S.C.Kaushic and A.N.Mathur. Himanshu Publication, Udaipur.
2. Green House Technology- Application and Practice. Sharma A and V.M.Salokhe. 2006. Agro Tech. publication, Udaipur
3. Principles of Agricultural Engineering, Vol. I. 2012. Michael, A.M. and T. P. Ojha . Jain Brothers, New Delhi.
4. Post Harvest Technology of Cereals, Pulses and Oil Seeds.1999. Chakravarty, A. Oxford and IBH Pub. New Delhi.
5. Agricultural Process Engineering. 1955. Henderson, S.M. and R.L. Perry. John Willy and Sons, New York.
6. Unit operation of Agriculture Processing. 2004. Shay K.M. and Singh, K.K. Vikas Publication House, New Delhi.

S.No.	Course code	Title of the course	
1	AGRON-111	Fundamentals of Agronomy	4(3+1)
2.	AGHR-111	Agricultural Heritage	1(1+0)*
3.	AGRON-121	Introduction Agrometeology & Climate change	2(1+1)
4.	AGRON-211	Crop Production Technology – I (*Kharif* crops)	3(2+1)
5	AGRON-221	Crop Production Technology – II (*Rabi* crops)	2(1+1)
6.	AGRON-222	Farming System & Sustainable Agriculture	1(1+0)
7.	AGRON-311	Geoinformatics and Nanotechnology and Precision Farming	2(1+1)
8.	AGRON-312	Practical Crop Production – I (*Kharif* crops)	2(0+2)
9.	AGRON-321	Rainfed Agriculture & Watershed Management	2(1+1)
10.	AGRON-322	Practical Crop Production – II (Rabi crops)	2(0+2)
11.	AGRON-323	Principles of Organic Farming	2(1+1)

AGRONOMY

AGRON-111	**Fundamentals of Agronomy**	**4(3+1)**

Theory

Agronomy and its scope, seeds and sowing, tillage and tilth, crop density and geometry, Crop nutrition, manures and fertilizers, nutrient use efficiency, water resources, soil plant water relationship, crop water requirement, water use efficiency, irrigation- scheduling criteria and methods, quality of irrigation water, water logging.

Weeds- importance, classification, crop weed competition, concepts of weed management-principles and methods, herbicides- classification, selectivity and resistance, allelopathy.

Growth and development of crops, factors affecting growth and development, plant ideotypes, crop rotation and its principles, adaptation and distribution of crops, crop management technologies in problematic areas, harvesting and threshing of crops.

Practical

Identification of crops, seeds, fertilizers, pesticides and tillage implements, Effect of sowing depth on germination and seedling vigour, Identification of weeds in crops, Methods of herbicide and fertilizer application, Study of yield contributing characters and yield estimation, Seed germination and viability test, Numerical exercises on fertilizer requirement, plant population, herbicides and water requirement, Use of tillage implements-reversible plough, one

way plough, harrow, leveler, seed drill, Study of soil moisture measuring devices, Measurement of field capacity, bulk density and infiltration rate, Measurement of irrigation water.

Lecture schedule : Theory

S.No.	Topic	No. of lectures
1.	Agriculture-definition and importance of agriculture	1
2.	Agronomy-meaning and scope of Agronomy	1
3.	Types of seeds, dormancy of seeds	1
4.	Viability of seeds, seed treatment	1
5.	Sowing-methods, depth, plant density	1
6.	Nursery bed and transplanting	1
7.	Crop density and geometry	1
8.	Optimum plant population	1
9.	Tillage-definition and types of tillage including minimum and no tillage.	1
10.	Tilth-definition and characteristics of good tilth.	1
11.	Crop nutrition-essential nutrients-classification	1
12.	Nutrient mobility in plants, Factors affecting nutrient availability	1
13.	Functions and deficiency symptoms of primary nutrients	1
14.	Manures –types, nutrient content ,	1
15.	Green manures, compost	1
16.	Fertilizers , INM	1
17.	Nutrient use efficiency	1
18.	Irrigation : definition and objectives	1
19.	Water resources and irrigation development in India and Rajasthan.	1
20.	Soil moisture constants and theories of soil water availability	1
21.	Crop water requirement and factors affecting it	1
22.	Scheduling of irrigation : meaning and different approaches for scheduling irrigation in field crops.	1
23.	Surface methods of irrigation ; border , furrow , check basin and basin methods	1
24.	Sprinkler and drip methods; their layout, adaptability , advantages and limitations.	1
25.	Irrigation efficiency ; different terms used and their importance.	1

26.	Water use efficiency -factors affecting and agronomic techniques to boost WUE	1
27.	Irrigation water quality- different criteria and limits used, effect of poor quality water on plant growth .	1
28.	Management practices for efficient use of poor quality waters including conjunctive use of water.	1
29.	Agricultural drainage- definition, benefits and different methods of drainage.	1
30.	Growth and development of crops,	1
31.	factors affecting growth and development,	1
32.	Plant ideotypes,	1
33	Crop rotation and its principles,	1
34	Adaptation and distribution of crops,.	1
35	Crop management technologies in problematic areas,	1
36	Harvesting and threshing of crops	1
37	Weeds – definition , harmful and beneficial effects and classification	1
38	Ecology of weeds	1
39	Weed - reproduction and seed dissemination	1
40	Crop-weed competition-concept and allelopathy	1
41	Concepts of weed prevention, eradication and weed control	1
42	Physical and cultural methods of weed control	1
43	Chemical and biological methods of weed control	1
44	Integrated weed management - An introduction	1
45	Introduction to herbicides, advantages and limitations of herbicides usages	1
46	Classification of herbicides	1
47	Herbicidal selectivity and resistance	1
48	Allelopathy	1

Lecturer schedule: Practical

S.No.	Topic	No. of lectures
1	Identification of crops, seeds, fertilizers,	1
2	Common Pesticides in agriculture	1

3	Study of agro-climatic zones of India and Rajasthan	1
4	Identification of weeds in crops	1
5	Methods of herbicide and fertilizer application,	1
6	Study of yield contributing characters and yield estimation,	1
7	Seed germination and viability test	1
8	Numerical exercises on fertilizer requirement of crops	1
9	Plant geometry and plant population of various crops	1
10	Herbicides requirement calculations and water requirement	1
11	Use of tillage implements-reversible plough, one way plough, harrow, leveler, seed drill,	1
12	Study of soil moisture measuring devices	1
13	Measurement of field capacity	1
14	Determination of bulk density	1
15	Determination of infiltration rate	1
16	Measurement of irrigation water	1

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2. Panda, S.C. 2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
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AGHR-111	Agricultural Heritage (New Course)	1(1+0)*

Theory

Introduction of Indian agricultural heritage; Ancient agricultural practices, Relevance of heritage to present day agriculture; Past and present status of agriculture and farmers in society; Journey of Indian agriculture and its development from past to modern era; Plant production and protection through indigenous traditional knowledge; Crop voyage in India and world; Agriculture scope; Importance of agriculture and agricultural resources available in India; Crop significance and classifications; National agriculture setup in India; Current scenario of Indian agriculture; Indian agricultural concerns and future prospects.

S.No.	Topic	No. of lectures
1.	Introduction of Indian agricultural heritage	1
2.	Ancient agricultural practices,	1
3.	Relevance of heritage to present day agriculture	1
4.	Past and present status of agriculture and farmers in society	2
5.	Journey of Indian agriculture and its development from past to modern era;	1
6.	Plant production and protection through indigenous traditional knowledge;	2
7.	Crop voyage in India and world;	1
8.	Agriculture -scope; Importance of agriculture and agricultural resources available in India;	1
9.	Crop significance and classifications;	1
10	Classification of crops-botanical, agronomic, seasonal.	1
11.	Classification of crops based on life span, special purposes i.e. cover, green manure, catch, trap, cash, soiling.	1
12.	National agriculture setup in India;	1
13.	Current scenario of Indian agriculture;	1
14.	Indian agricultural concerns and future prospects.	1

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AGRON-121	**Introduction Agrometeology & Climate change**	**2(1+1)**

Theory

Earth atmosphere- its composition, extent and structure; Atmospheric weather variables; Atmospheric pressure, its variation with height; Wind, types of wind, daily and seasonal variation of wind speed, cyclone, anticyclone, land breeze and sea breeze; Nature and properties of solar radiation, solar constant, depletion of solar radiation, short wave, longwave and thermal radiation, net radiation, albedo; Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature, Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure, process of condensation, formation of dew, fog, mist, frost, cloud; Precipitation, process of precipitation, types of precipitation such as rain, snow, sleet, and hail, cloud formation and classification; Artificial rainmaking. Monsoon- mechanism and importance in Indian agriculture, Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave. Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production. Weather forecasting- types of weather forecast and their uses. Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.

Practical

Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording. Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law. Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS. Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis. Measurement of soil temperature and computation of soil heat flux. Determination of vapor pressure and relative humidity. Determination of dew point temperature. Measurement of atmospheric pressure and analysis of atmospheric conditions. Measurement of wind speed and wind direction, preparation of windrose. Measurement, tabulation and analysis of rain. Measurement of open pan evaporation and evapotranspiration. Computation of PET and AET

Lecture schedule : Theory

S.No	Topic	No. of lectures
1.	Meaning and scope of agricultural meteorology	1
2.	Earths atmosphere- its composition, extent and structure	1
3.	Atmospheric weather variables; Atmospheric pressure, its variation with height	1
4.	Wind, types of wind, daily and seasonal variation of wind speed	1
5.	Cyclone, anticyclone, land breeze and sea breeze	1
6.	Nature and properties of solar radiation, solar constant, depletion of solar radiation	1
7.	Short wave, longwave and thermal radiation, net radiation, albedo	1
8.	Atmospheric temperature, temperature inversion, lapse rate, daily and seasonal variations of temperature, vertical profile of temperature,	1
9.	Energy balance of earth; Atmospheric humidity, concept of saturation, vapor pressure,	1
10.	Process of condensation, formation of dew, fog, mist, frost, cloud	1
11.	Precipitation- process , types such as rain, snow, sleet, and hail	1
12.	Cloud formation and classification; Artificial rainmaking, Monsoon-mechanism and importance in Indian agriculture	1
13.	Weather hazards - drought, floods, frost, tropical cyclones and extreme weather conditions such as heat-wave and cold-wave	1
14.	Agriculture and weather relations; Modifications of crop microclimate, climatic normals for crop and livestock production	1
15.	Weather forecasting- types of weather forecast and their uses	1
16.	Climate change, climatic variability, global warming, causes of climate change and its impact on regional and national Agriculture.	1

Lecturer schedule: Practical

S.No.	Topic	No. of lectures
1	Visit of Agrometeorological Observatory, site selection of observatory, exposure of instruments and weather data recording.	2
2	Measurement of total, shortwave and longwave radiation, and its estimation using Planck's intensity law.	2
3	Measurement of albedo and sunshine duration, computation of Radiation Intensity using BSS.	2

4	Measurement of maximum and minimum air temperatures, its tabulation, trend and variation analysis.	1
5	Measurement of soil temperature and computation of soil heat flux.	1
6	Determination of vapor pressure and relative humidity.	1
7	Determination of dew point temperature.	1
8	Measurement of atmospheric pressure and analysis of atmospheric conditions.	1
9	Measurement of wind speed and wind direction, preparation of windrose.	1
10	Measurement, tabulation and analysis of rain.	1
11	Measurement of open pan evaporation and evapotranspiration.	1
12	Computation of PET and AET.	2

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AGRON-211	**Crop Production Technology – I (*Kharif* crops)**	**3(2+1)**

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Kharif* crops. Cereals – rice, maize, sorghum, pearl millet and finger millet, pulses- pigeonpea, mungbean and urdbean; oilseeds- groundnut, and soybean; fibre crops- cotton & Jute; forage crops-sorghum, cowpea, cluster bean and napier.

Practical

Rice nursery preparation, transplanting of Rice, sowing of soybean, pigeonpea and mungbean. maize, groundnut and cotton, effect of seed size on germination and seedling vigour of *kharif* season crops, effect of sowing depth on germination of kharif crops, identification of weeds in *kharif* season crops, top dressing and foliar feeding of nutrients, study of yield contributing characters and yield calculation of *kharif* season crops, study of crop varieties and important agronomic experiments at experimental farm. study of forage experiments, morphological description of *kharif* season crops, visit to research centres of related crops.

Lecture schedule:Theory

S.No.	Topic	No. of lectures
1.	Pearl millet-importance, origin, distribution ,production, soil and climatic requirement (grain & forage).	1
2.	Pearl millet- improved varieties,(grain and forage) seed and sowing, intercultural operation/weed management, mid-season corrections, intercropping and fertilizer management (grain & forage).	1
3.	Pearl millet-water management, plant protection measures, harvesting, yield and cutting management in forage	1
4.	Maize- importance, origin, distribution, production , soil and climatic requirement, improved varieties, seed and sowing	1
5.	Maize- intercultural operations/weed management, fertilizer and water management, plant protection measures, harvesting and yield	1
6.	Sorghum- importance, origin, distribution, production, soil and climatic requirement and improved varieties for grain and forage	1
7.	Sorghum- seed and sowing, intercultural operations/weed management, fertilizer, and water management for grain and forage	1
8.	Sorghum- plant protection measures, harvesting, yield and cutting management in forage	1
9.	Rice- importance, origin, distribution, production, soil and climatic requirement.	1
10.	Rice-improved varieties, nursery raising, seed and sowing, intercultural operations/ weed management, fertilizer and water management	1
11.	Rice-plant protection measures, harvesting, processing and yield	1
12.	Groundnut – importance of oilseeds and groundnut, origin, distribution, production, soil and climatic requirements	1
13.	Groundnut-growth habits , improved varieties, seed and sowing, pegging	1
14.	Groundnut –intercultural operations/ weed management , fertilizer, and water management, plant protection measures, harvesting shelling and yield	1
15.	Soybean – importance, origin, distribution, production, soil and climatic	1

	requirement, improved varieties, seed and sowing	
16.	Soybean- fertilizer, water and weed management, plant protection measures, harvesting and yield	1
17.	Pigeon pea- importance of pulses and pigeon pea , origin, distribution, soil and climatic requirement, improved varieties	1
18.	Pigeon pea- seed and sowing, intercultural operations/weed management fertilizer and water management, plant protection measures, harvesting and yield	1
19.	Cotton- importance, origin, distribution, production, soil and climatic requirements, types of cotton, improved varieties	1
20.	Cotton- seed and sowing, intercultural operations; weed management, fertilizer, and water management	1
21.	Cotton- plant protection measures, harvesting, quality and yield	1
22.	Clusterbean – package of practices	1
23.	Sesame- package of practices	1
24.	Castor – package of practices	1
25.	Mothbean- package of Practices	1
26.	Urdbean -package of practices	1
27.	Mungbean package of practices	1
28.	Cowpea – package of practices	1
29.	Napier - package of practices	1
30.	Minor millets - package of practices	1
31.	Sunhemp – package of practices	1
32.	Acquaintance about *Panicum , Lasiuras and Cenchrus*	1

Lecturer schedule: Practical

S.No.	Topic	No. of lectures
1.	Identification of seeds, crops and other inputs of kharif season	1
2.	Sowing methods of different *kharif* crops	1
3.	Seed bed preparation of *kharif* crops including rice nursery and transplanting	1
4.	Working out seed rate, real value, seed size, depth and germination related numerical	1
5.	Seed treatment and preparation of seed material for sowing	1
6.	Preparation of seed material for planting of grasses	1

7.	Fertilizer application in crops, including top dressing and foliar feeding	1
8.	Identification of weeds in *kharif* season crops	1
9.	Morphological description of *kharif* season crops	1
10.	Irrigation operation in various crops	1
11.	Judging physiological maturity in standing crops	1
12.	Cotton seed treatment	1
13.	Effect of seed size on germination and seedling vigour	1
14.	Yield attributes and calculation on theoretical yield and harvest index	1
15.	Study of crop varieties and important agronomic and forage experiments at farm	1
16.	Visit of experiments at farm/research centres of related crops	1

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2. Panda, S.C.2012. Modern Concepts and Advance Principles in Crop Production. Agrobios (India), Jodhpur
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AGRON-221	**Crop Production Technology – II (*Rabi* crops)**	**2(1+1)**

Theory

Origin, geographical distribution, economic importance, soil and climatic requirements, varieties, cultural practices and yield of *Rabi* crops; cereals –wheat and barley, pulses-chickpea, lentil, peas,

oilseeds-rapeseed, mustard and sunflower; sugar crops-sugarcane; medicinal and aromatic crops-mentha, lemon grass and citronella, Forage crops- berseem, lucerne and oat.

Practical

Sowing methods of wheat and sugarcane, identification of weeds in *rabi* season crops, study of morphological characteristics of *rabi* crops, study of yield contributing characters of *rabi* season crops, yield and juice quality analysis of sugarcane, study of important agronomic experiments of *rabi* crops at experimental farms. Study of *rabi* forage experiments, oil extraction of medicinal crops, visit to research stations of related crops.

Lecture schedule :Theory

S.No.	Topic	No. of lectures
1.	Wheat- importance, origin, distribution, production, soil and climatic requirement	1
2.	Wheat- improved varieties, seed and sowing, intercultural operations/ weed management	1
3.	Wheat- water and fertilizer management and importance of CRI stage.	1
4.	Wheat- plant protection , harvesting and yield and acquaintance about triticale	1
5.	Barley- Importance , origin, distribution, production, soil and climatic requirement and improved varieties	1
6.	Barley- seed and sowing, intercultural operations/ weed management, fertilizer and water management, plant protection measures, harvesting and yield .	1
7.	Rapeseed and mustard – importance , origin, distribution, production, classification , soil and climatic requirement .	1
8.	Rapeseed and mustard – improved varieties, seed and sowing, intercultural operations/ weed management and fertilizer management	1
9.	Rapeseed and mustard – water management, plant protection measures, harvesting and yield	1
10.	Chickpea- importance, origin, distribution, production, soil and climatic requirement and improved varieties.	1
11.	Chickpea –seed and sowing, intercultural operations/ weed management, fertilizer and water management, plant protection measures, harvesting and yield.	1
12.	Sugarcane- importance, origin, distribution, production, soil and climatic requirement.	1
13.	Sugarcane- improved varieties, seed and transplanting , intercultural operations/weed management and fertilizer management.	1

14.	Sugarcane- water management and plant protection measures.	1
15.	Sugarcane- maturity, harvesting and yield and factors affecting quality.	1
16.	Potato- importance, origin, distribution, production, soil and climatic requirement, improved varieties, seed and sowing .	1
17.	Potato- seed plot technique, intercultural operations/weed management, fertilizer and water management, plant protection measures , harvesting and yield .	1
18.	Lucerne – importance , soil and climatic requirement, improved varieties and seed and sowing	1
19.	Lucerne- weed, fertilizer and water management , cutting management and yield.	1
20.	Tobacco-.package of practices	1
21.	Sunflower- package of practices	1
22.	Linseed- package of practices	1
23.	Safflower – package of practices	1
24.	Taramira - package of practices	1
25.	Sugarbeet- package of practices	1
26.	Lentil- package of practices	1
27.	Pea and Frenchbean - package of practices	1
28.	Medicinal and aromatic crops-mentha, lemon grass and citronella	1
29.	Berseem - package of practices	1
30.	Isabgol - package of practices	1
31.	Oats - package of practices	1
32.	Opium poppy- package of practices	1

Lecture schedule: Practical

S.No.	Topic	No. of lectures
1.	Identification of seeds, crops and other inputs of *rabi* season	1
2.	Identification of weeds in *rabi* season crops	1
3.	Seed rate and related numerical	1
4.	Sowing of wheat and planting of sugarcane.	1
5.	Application of herbicides and related numericals.	1
6.	Judging physiological maturity of various crops	1
7.	Fertilizer application in crops and related numerical	1

8.	Morphological difference in wheat, barley and oat, rapeseed and mustard, berseem and lucerne.	1
9.	Judging sugarcane maturity based on brix ratio and related calculation	1
10.	Yield attributing characters, Theoretical yield and related numerical	1
11.	Crop harvesting and related numericals on harvest index.	1
12.	Working out seed index (test weight) and cost of cultivation.	1
13.	Oil extraction of medicinal crops	1
14.	Study of *rabi* forage experiments	1
15.	Study of important agronomic experiments of *rabi* crops at experimental farms	1
16.	Visit to research stations of related crops	1

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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.
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AGRON-222	**Farming System & Sustainable Agriculture**	**1(1+0)**

Theory

Farming System-scope, importance, and concept, Types and systems of farming system and factors affecting types of farming, Farming system components and their maintenance, Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation, Allied enterprises and

their importance, Tools for determining production and efficiencies in cropping and farming system; Sustainable agriculture-problems and its impact on agriculture, indicators of sustainability, adaptation and mitigation, conservation agriculture strategies in agriculture, HEIA, LEIA and LEISA and its techniques for sustainability, Integrated farming system-historical background, objectives and characteristics, components of IFS and its advantages, Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques, Resource cycling and flow of energy in different farming system, farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.

Lecture schedule :Theory

S.No.	Topic	No. of lectures
1.	Farming System-scope, importance, and concept	1
2.	Types and systems of farming system and factors affecting types of farming	1
3.	Farming system components and their maintenance,	1
4.	Cropping system and pattern, multiple cropping system, Efficient cropping system and their evaluation	1
5.	Allied enterprises and their importance, Tools for determining production and efficiencies in cropping and farming system	2
6.	Sustainable agriculture-problems and its impact on agriculture	1
7.	indicators of sustainability, adaptation and mitigation,	1
	conservation agriculture strategies in agriculture	1
8.	LEIA (Low external input agriculture),LEISA	1
9.	HEIA (High external input agriculture)	1
10.	Integrated farming system-historical background, objectives and characteristics,	1
11.	components of IFS and its advantages,	1
12.	Site specific development of IFS model for different agro-climatic zones, resource use efficiency and optimization techniques,	1
13.	Resource cycling and flow of energy in different farming system,	1
14.	farming system and environment, Visit of IFS model in different agro-climatic zones of nearby states University/ institutes and farmers field.	1

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AGRON-311	Geoinformatics and Nanotechnology and Precision Farming	2(1+1)

Theory

Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture; Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture. Crop discrimination and Yield monitoring, soil mapping; fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS; Remote sensing concepts and application in agriculture; Image processing and interpretation; Global positioning system (GPS), components and its functions; Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs; STCR approach for precision agriculture; Nanotechnology, definition, concepts and techniques, brief introduction about nanoscale effects, nano-particles, nano-pesticides, nano-fertilizers, nano-sensors, Use of nanotechnology in seed, water, fertilizer, plant protection for scaling-up farm productivity.

Practical

Introduction to GIS software, spatial data creation and editing. Introduction to image processing software. Visual and digital interpretation of remote sensing images. Generation of spectral profiles of different objects. Supervised and unsupervised classification and acreage estimation. Multispectral remote sensing for soil mapping. Creation of thematic layers of soil fertility based on GIS. Creation of productivity and management zones. Fertilizers recommendations based of VRT and STCR techniques. Crop stress (biotic/abiotic) monitoring using geospatial technology. Use of GPS for agricultural survey. Formulation, characterization and applications of nanoparticles in agriculture. Projects formulation and execution related to precision farming.

Lecture schedule-Theory

S.No.	Topic	No. of lectures
1.	Precision agriculture: concepts and techniques; their issues and concerns for Indian agriculture;	2
2.	Geo-informatics- definition, concepts, tool and techniques; their use in Precision Agriculture	1
3.	Crop discrimination and Yield monitoring, soil mapping;	1

4.	fertilizer recommendation using geospatial technologies; Spatial data and their management in GIS;	2
5.	Remote sensing concepts and application in agriculture;	1
6.	Image processing and interpretation;	1
7.	Global positioning system (GPS), components and its functions;	1
8.	Introduction to crop Simulation Models and their uses for optimization of Agricultural Inputs;	1
9.	STCR approach for precision agriculture;	1
10	Nanotechnology, definition, concepts and techniques,	1
11.	brief introduction about nanoscale effects,	1
12.	nano-particles, nano-pesticides, nano-fertilizers, nano-sensors,	1
13.	Use of nanotechnology in seed and water for scaling-up farm productivity	1
14.	Use of nanotechnology in fertilizer and plant protection for scaling-up farm productivity	1

Lecture schedule:Practical

S.No.	Topic	No. of lectures
1.	Introduction to GIS software, spatial data creation and editing.	2
2.	Introduction to image processing software. Visual and digital interpretation of remote sensing images.	2
3.	Generation of spectral profiles of different objects.	2
4.	Supervised and unsupervised classification and acreage estimation.	2
5.	Multispectral remote sensing for soil mapping.	1
6.	Creation of thematic layers of soil fertility based on GIS.	1
7.	Creation of productivity and management zones	1
8.	Fertilizers recommendations based of VRT and STCR techniques.	1
9.	Crop stress (biotic/abiotic) monitoring using geospatial technology.	1
10	Use of GPS for agricultural survey.	1
11.	Formulation, characterization and applications of nanoparticles in agriculture.	1
12.	Projects formulation and execution related to precision farming	1

References:

1. Krishna, K.K. 2013. Precision Farming: Soil Fertility and Productivity Aspects. Apple Academic Press
2. Srivastava, G.S. 2014. An Introduction to Geoinformatics. McGrew Hill Education (India) Pvt. Ltd. , New Delhi
3. Gupta, R.K. and Subhash Chander. 2008. Principles of Geoinformatics. Jain Brothers, New Delhi.
4. Choudhary, S. 2011. Applied Nanotechnology in Agriculture. Arise Publishers & Distributors
5. Sekhon, B.S. 2014. Nanotechnology in agri-food production: an overview. *Nanotechnology, Science and Applications* **7**:31-532.

AGRON-312	**Practical Crop Production – I (*Kharif* crops)**	**2(0+2)**

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

Lecture schedule : Practical

S.No.	Topic	No. of lectures
1.	Introduction of the course, crop planning and allotment of field	1
2.	Field preparation, application of manures and fertilizers	1
3.	Selection of crop and varieties, seed treatment and sowing	1
4.	Sowing of crops.	1
5.	Observation of germination	1
6.	Thinning and gap filling	1
7.	Intercultural operations-hoeing and weeding	1
8.	Intercultural operations-hoeing and weeding	1
9.	Water management- application of irrigation water and demonstrating methods of irrigation	1
10.	Top dressing of fertilizer (urea).	1
11.	Insect and pest management (control)- application of insecticides	1
12.	Disease management (control)- application of fungicides	1
13.	Harvesting	1
14.	Threshing, winnowing and storage	1
15.	Marketing of produce	1
16.	Preparation of balance sheet including estimating cost of cultivation and net return per student as well as per team of a group of student	1

References:

1. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2008. Manures and Fertilizers (10th edition), Agri-Horticultural Publishing House, Nagpur.
2. Balasubramaniyan, P. and Palaniappan, S.P. 2016. Principles and Practices of AgronomyAgrobios (India), Jodhpur.
3. Reddy, S. R., 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
4. Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

AGRON-321	**Rainfed Agriculture & Watershed Management**	**2(1+1)**

Theory

Rainfed agriculture: Introduction, types, History of rainfed agriculture and watershed in India; Problems and prospects of rainfed agriculture in India ; Soil and climatic conditions prevalent in rainfed areas; Soil and water conservation techniques, Drought: types, effect of water deficit on physio- morphological characteristics of the plants, Crop adaptation and mitigation to drought; Water harvesting: importance, its techniques, Efficient utilization of water through soil and crop management practices,Management of crops in rainfed areas, Contingent crop planning for aberrant weather conditions, Concept, objective, principles and components of watershed management, factors affecting watershed management.

Practical

Studies on climate classification, studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons. Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India. Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops. Critical analysis of rainfall and possible drought period in the country, effective rainfall and its calculation. Studies on cultural practices for mitigating moisture stress. Characterization and delineation of model watershed. Field demonstration on soil & moisture conservation measures. Field demonstration on construction of water harvesting structures. Visit to rainfed research station/watershed.

Lecture schedule: Theory

S.No.	Topic	No. of lectures
1.	Rainfed agriculture- definition, history and its importance in India with particular to references Rajasthan	1
2.	Problems of dryland agriculture related to climate, soil, technological and socio economic conditions	1

3.	Soil and water conservation techniques,	1
4.	Drought: types,	1
5.	effect of water deficit on physio- morphological characteristics of the plants,	1
6.	Use of antitranspirants-their kind, mode of action and effect on crop yield.	1
7.	Crop adaptation and mitigation to drought;	1
8.	Water harvesting: importance, its techniques,	1
9.	Efficient utilization of water through soil and crop management practices,	1
10.	Water harvesting techniques in dry farming areas	1
11.	Watershed management- concept, definition, objectives and principles	1
12.	Integrated watershed management for drylands	1
13.	A study of model watershed area	1
14.	Management of crops in rainfed areas,	1
15.	Contingent crop planning for aberrant weather conditions,	1
16.	Alternate cropping and land use strategies for dryland agriculture	1

Lecture schedule: Practical

S.No.	Topic	No. of lectures
1.	Studies on climate classification,	1
2.	studies on rainfall pattern in rainfed areas of the country and pattern of onset and withdrawal of monsoons.	1
3.	Studies on cropping pattern of different rainfed areas in the country and demarcation of rainfed area on map of India.	1
4.	Interpretation of meteorological data and scheduling of supplemental irrigation on the basis of evapo-transpiration demand of crops.	1
5.	Critical analysis of rainfall and estimation of moisture index and aridity index and possible drought period in the country	1
6.	Field demonstration on construction of water harvesting structures	1
7.	effective rainfall and its calculation.	1
8.	Studies on cultural practices for mitigating moisture stress.	1
9.	Spray of antitranspirants on dryland crops and their effect on crops	1
10.	Characterization and delineation of model watershed	1
11.	Field demonstration on soil & moisture conservation measures	1

12.	Crops and cropping systems for drylands	1
13.	Acquiring skill in tillage methods for *in-situ* moisture c onservation	1
14.	Mulching and its effects on soil moistures conservation	1
15.	Seed soaking, seed treatment with chemicals for sowing in dryland areas	1
16.	Visit to rainfed research station/watershed.	1

References:

1. Jayanthi, C. and Kalpana, R. 2016. Dryland Agriculture, Kalyani Publishers, Ludhiana.
2. Reddy, S.R. and Reddy, G. Prabhakara. 2015. Dryland Agriculture, Kalyani Publishers, Ludhiana.
3. Murthy, J. V. S. 1994. Watershed Management, Wiley Eastern Limited. New Age International Limited, New Delhi.
4. 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.
5. 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.
6. Singh, P.K. 2000. Watershed Management (Design & Practices), e-media Publication, Udaipur, India.
7. Singh, R.P. 1995, Sustainable Development of Dryland Agriculture in India. Scientific Publishers, Jodhpur.
8. Singh, S.S., 1993, Crop Management Under Irrigated and Rainfed Conditions, Kalyani Publishers, New Delhi.

AGRON-322	**Practical Crop Production – II (Rabi crops)**	**1(0+1)**

Practical

Crop planning, raising field crops in multiple cropping systems: Field preparation, seed, treatment, nursery raising, sowing, nutrient, water and weed management and management of insect-pests diseases of crops, harvesting, threshing, drying winnowing, storage and marketing of produce. The emphasis will be given to seed production, mechanization, resource conservation and integrated nutrient, insect-pest and disease management technologies. Preparation of balance sheet including cost of cultivation, net returns per student as well as per team of 8-10 students.

Lecture schedule :Practical

S.No.	Topic	No. of lectures
1.	Allotment of land and field preparation	1
2.	Sowing methods	1

3.	Selection of crops and varieties	1
4.	Seed treatment	1
5.	Preparation of seed bed and sowing of crops	1
6.	Thinning and gap filling	1
7.	Fertilizer application including top dressing of fertilizers	1
8.	Intercultural operations- hoeing and weeding	1
9.	Intercultural operations- hoeing and weeding	1
10.	Application of moisture conservation practices	1
11.	Insect and pest management /control –application of insecticides.	1
12.	Disease management/control –application of fungicides	1
13.	Harvesting of the crops	1
14.	Threshing, winnowing and storage	1
15.	Marketing of produce	1
16.	Preparation of balance sheet including cost of cultivation and net return per student as well as team of a group of student	1

References:

1. Yawalkar, K.S., Agarwal, J.P. and Bokde, S. 2008. Manures and Fertilizers (10th edition), Agri-Horticultural Publishing House, Nagpur.
2. Balasubramaniyan, P. and Palaniappan, S.P.2016. Principles and Practices of Agronomy (2nd edition), Agrobios (India), Jodhpur.
3. Reddy, S. R. 2016. Principles of Agronomy (5th edition), Kalyani Publishers, Ludhiana.
4. Singh, S.S. and Singh, Rajesh. 2015. Principles and Practices of Agronomy (5th Re-set), Kalyani Publishers, New Delhi, Kalyani Publishers, Ludhiana.

AGRON-323	**Principles of Organic Farming**	**2(1+1)**

Theory

Organic farming, principles and its scope in India; Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture; Organic ecosystem and their concepts; Organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Fundamentals of insect, pest, disease and weed management under organic mode of production; Operational structure of NPOP; Certification process and standards of organic farming; Processing, leveling, economic considerations and viability, marketing and export potential of organic products.

Practical

Visit of organic farms to study the various components and their utilization; Preparation of enrich compost, vermicompost, bio-fertilizers/bio-inoculants and their quality analysis; Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management; Cost of organic production system; Post harvest management; Quality aspect, grading, packaging and handling.

Lecture Schedule--Theory

S.No.	Topic	No. of lectures
1.	Organic farming, principles and its scope in India;	2
2.	Initiatives taken by Government (central/state), NGOs and other organizations for promotion of organic agriculture;	1
3.	Organic ecosystem and their concepts;	1
4.	Organic nutrient resources and its fortification;	1
5.	Restrictions to nutrient use in organic farming;	1
6.	Choice of crops and varieties in organic farming;	1
7.	Fundamentals of insect, pest, disease mgt	2
8.	weed management under organic mode of production;	1
9.	Operational structure of NPOP	2
10.	Certification process and standards of organic farming;	2
11.	Processing, leveling, economic considerations and viability,	1
12.	marketing and export potential of organic products	1

Lecture Schedule--Practical

S.No.	Topic	No. of lectures
1.	Visit of organic farms to study the various components and their utilization;	2
2.	Preparation of enrich compost,	2
3.	vermicompost,	2
4.	bio-fertilizers/bio-inoculants and their quality analysis;	2
5.	Indigenous technology knowledge (ITK) for nutrient, insect, pest disease and weed management;	2
6.	Cost of organic production system;	2
7.	Post harvest management;	2
8.	Quality aspect, grading, packaging and handling.	2

References:

1. Dhama, A.K. 2014. Organic Farming for Sustainable Agriculture (2nd edition), Agrobios (India), Jodhpur.
2. Sharma, Arun K. 2013. 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, Agrtech, Publising Academy, Udaipur.
5. शर्मा, अरूण के. 2015. जैविक खेती – नई दिशाए, एग्रोबायोस (इण्डिया), जोधपुर

Biochemistry – Annexures -IV (1)

BIOCHEMISTRY

BIOCHEM-111	**Fundamentals of Plant Biochemistry and Biotechnology**	**3(2+1)**

Theory

Importance of Biochemistry; Properties of Water, pH and Buffer.

Carbohydrate: Importance and Classification, Reducing and Nonreducing sugars, Structures and properties of Monosaccharides, Disaccharides and Polysaccharides.

Lipid: Importance and classification, Structures and properties of fatty acids including membrane lipids.

Proteins: Importance and classification, Structures, titration and zwitter ion nature of amino acids, Structural organization of proteins.

Enzymes: General properties, Classification, Mechanism of action, Allosteric enzymes.

Nucleic acids: Importance and classification, Structure of Nucleotides, Secondary and Tertiary structures.

Metabolism of carbohydrates including Glycolysis, TCA cycle and Electron Transport Chain. Metabolism of lipids: Beta oxidation and Biosynthesis.

Plant Biotechnology: Concepts, Scope and applications. Scope and applications of organ cultures, embryo, cell suspension, callus, anther, pollen and ovule culture.

Micro-propagation methods: Organogenesis, Embryogenesis, Synthetic seeds and their significance; Embryo rescue and its significance, Somatic hybridization and cybrids.

Somaclonal variation and its use in crop improvement and Cryo-preservation.

Introduction to recombinant DNA methods: Physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods.

Transgenics: PCR techniques and its applications including Molecular Markers in crop improvement and Biotechnology regulations.

Practical

Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids.

Quantitative estimation of glucose/ proteins. Estimation of amino acids/lipids, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides.

Sterilization techniques. Demonstration of isolation of DNA and gel electrophoresis techniques

Lecture Schedule – Theory

1. Importance of Biochemistry; Properties of Water, pH and Buffer. 1
2. Carbohydrate: Importance and Classification, Reducing and Non reducing sugars. 1
3. Structures and properties of Monosaccharides, Disaccharides and Polysaccharides. 2
4. Lipid: Importance and classification. 1
5. Structures and properties of fatty acids including membrane lipids. 2
6. Proteins: Importance and classification, Structures. 2
7. Titration and zwitter ion nature of amino acids. 1
8. Structural organization of proteins. 1
9. Enzymes: General properties, Classification. 1
10. Mechanism of action, Allosteric enzymes. 1
11. Nucleic acids: Importance and classification, Structure of Nucleotides. 1
12. Secondary and Tertiary structures of nucleic acids. 1
13. Metabolism of carbohydrates including Glycolysis. 1
14. TCA cycle and Electron Transport Chain. 2
15. Metabolism of lipids: Beta oxidation and Biosynthesis. 2
16 Plant Biotechnology: Concepts, Scope and applications. 1
17. Scope and applications of organ cultures, embryo, cell suspension, callus, anther, pollen and ovule culture. 3
18. Micro-propagation methods: Organogenesis, Embryogenesis, Synthetic seeds and their significance. 3
19. Embryo rescue and its significance. 1
20. Somatic hybridization and cybrids. 2
21. Somaclonal variation and its use in crop improvement and Cryo-preservation.
22. Introduction to recombinant DNA methods: Physical (Gene gun method), chemical (PEG mediated) and Agrobacterium mediated gene transfer methods. 3
23. Transgenics: PCR techniques and its applications. 1
24. Molecular Markers in crop improvement and Biotechnology regulations. 2

1.	ENTO-121	Fundamentals of Entomology	3(2+1)
2	ESDM-211	Environmental Studies and Disaster Management (to be shared with Soil Science & Agril. Chemistry)	3(3+0)
3.	ENTO-221	Insect Ecology and Principles of Integrated Pest Management (New Course)	2(1+1)
4.	ENTO-222	Bio-pesticides and Bio-fertilizers (Elective course)	3(2+1)
5.	ENTO-311	Pests of Crops and Stored grains and their Management	4(3+1)
6.	ENTO-321	Management of Beneficial Insects	2(1+1)

ENTOMOLOGY

ENTO-121	**Fundamentals of Entomology**	**3(2+1)**

Theory

Part - I

History of Entomology in India. Major points related to dominance of Insecta in Animal kingdom. Classification of phylum Arthropoda upto classes. Morphology: Structure and functions of insect cuticle and molting. Body segmentation. Structure of Head, thorax and abdomen. Structure and modifications of insect antennae, mouth parts, legs, Wing venation, modifications and wing coupling apparatus. Structure of male and female genital organ. Major sensory organs like simple and compound eyes, chemoreceptor. Metamorphosis in insects. Types of larvae and pupae. Structure and functions of digestive, circulatory, excretory, respiratory, nervous, secretary (endocrine) and reproductive system, in insects. Types of reproduction in insects.

Part-II

Systematics: Taxonomy –importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order. Classification of class Insecta upto Orders, basic groups of present day insects with special emphasis to orders and families of Agricultural importance like Orthoptera: Acrididae, Gryllidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae; Thysanoptera: Thripidae; Hemiptera: Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae; Neuroptera: Chrysopidae; Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Bombycidae; Coleoptera: Coccinellidae, Gelerucidae, Cerambycidae, Curculionidae, Bruchidae, Melonthidae; Hymenoptera: Tenthridinidae, Apidae. Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae; Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae.

Practical

Methods of collection and preservation of insects including immature stages; External features of Grasshopper/Cockroach; Types of insect antennae, mouthparts and legs; Wing venation, types of wings and wing coupling apparatus. Types of insect larvae and pupae; Dissection of digestive system in insects

(Grasshopper); Dissection of male and female reproductive systems in insects (Grasshopper); Study of characters of orders Orthoptera, Dictyoptera, Odonata, Isoptera, Thysanoptera, Hemiptera, Lepidoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and their families of agricultural importance.

Lecture Schedule
Theory

S.No.	Topic	Lectures
1.	History of Entomology in India.	1
2.	Major points related to dominance of Insecta in Animal kingdom.	1
3.	Classification of phylum Arthropoda upto classes.	1
4.	Structure and functions of insect cuticle and molting.	1
5.	**Morphology of grasshopper:** Body segmentation- structure of head, thorax and abdomen.	2
6.	Structure and modifications of insect antennae.	1
7.	Structure and modifications of insect mouth parts.	3
8.	Structure and modifications of insect leg.	1
9.	Wing venation, modifications and wing coupling apparatus.	1
10.	Structure of genital organs and sensory organs (simple and compound eyes, chemoreceptor).	2
11.	Metamorphosis in insects, types of larvae and pupae.	1
12.	Structure and functions of digestive system.	1
13.	Structure and functions of circulatory and excretory system.	2
14.	Structure and functions of respiratory system.	1
15.	Structure and functions of nervous system.	1
16.	Structure and functions of secretory (endocrine) system	1
17.	Structure and functions of reproductive system and types of reproduction in insects.	2
18.	**Taxonomy**- importance, history and development and binomial nomenclature. Definitions of Biotype, Sub-species, Species, Genus, Family and Order.	2
19.	Orthoptera: Acrididae, Gryllidae; Dictyoptera: Mantidae, Blattidae; Odonata; Isoptera: Termitidae. Thysanoptera: Thripidae.	2
20.	Hemiptera: Pentatomidae, Coreidae, Pyrrhocoridae, Lygaeidae, Cicadellidae, Delphacidae, Aphididae, Coccidae, Lophophidae, Aleurodidae, Pseudococcidae.	1
21.	Lepidoptera: Pieridae, Papiloinidae, Noctuidae, Sphingidae, Pyralidae, Gelechiidae, Arctiidae, Bombycidae.	1
22.	Coleoptera: Coccinellidae, Galerucidae, Cerambycidae, Curculionidae, Bruchidae, Melonthidae.	1

23.	Hymenoptera: Tenthridinidae, Apidae, Trichogrammatidae, lchneumonidae, Braconidae, Chalcididae.	1
24.	Diptera: Cecidomyiidae, Tachinidae, Agromyziidae, Culicidae, Muscidae, Tephritidae; Neuroptera: Chrysopidae.	1

Practical

S.No.	Practical	Lectures
1.	Methods of collection and preservation of insects including immature stages.	1
2.	External features of Grasshopper/Cockroach.	1
3.	Types of insect antennae, mouthparts and legs.	4
4.	Wing venation, types of wings and wing coupling apparatus.	1
5.	Dissection of digestive system in insects (Grasshopper/ Cockroach)	1
6.	Dissection of male and female reproductive systems in insects (Grasshopper/ Cockroach).	1
7.	Study of characters of orders Orthoptera, Dictyoptera with their families.	1
8.	Study of characters of orders Odonata, Isoptera, Thysanoptera with their families.	1
9.	Study of characters of order Hemiptera with its families.	1
10.	Study of characters of order Lepidoptera with its families.	1
11.	Study of characters of order Coleoptera with its families.	1
12.	Study of characters of order Diptera with its families.	1
13.	Study of characters of orders Hymenoptera and Neuroptera with their families.	1

Suggested Readings

1. Chapman .R.F.1981. Insect Structure and Function, ELBS Publishers New Delhi.
2. David B.V. and Ananthakrishnan .T.N. 2003. General and Applied Entomology, 2nd Ed. Mc graw Hill publishing Co. Ltd. New Delhi.
3. Mathur and Upadhyay, 2005. A Text Book of Entomology, Aman Publishing House, Meerut.
4. Pant. N.C. and Ghai, S. 1981. Insect Physiology and Anatomy, ICAR, New Delhi.
5. Richards O.W. and Davies R.G. 1977. Imm's General Text Book of Entomology, Vol. I & II. Chapman and Hall, London**.**
6. Snodgrass R.E .2001. Principles of Insect Morphology, CBS Publishers and Distributors, New Delhi.

ESDM-211	Environmental Studies and Disaster Management (to be shared with Soil Science & Agril. Chemistry)	3(3+0)

Theory

Environment: Definition, scope and importance. Natural Resources: Renewable and non-renewable resources, a) Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Ecology: Definition and scope. Ecosystems: Definition, concept, structure and function, components, producers, consumers and decomposers, Energy flow in the ecosystem. Ecological succession, Food chains, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Biodiversity and its conservation: - Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Threats to biodiversity. Conservation of biodiversity.

Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution. Thermal pollution g. Nuclear hazards. Solid Waste Management: causes, effects and control measures of urban and industrial wastes.

Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management. Environmental ethics: Issues and possible solutions. 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.

Disaster Management: Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.

Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.

Disaster Management- Concept of disaster management, national disaster management framework; financial arrangements; Central, state, district and local administration; NGO, Armed forces in disaster response; Disaster response; Police and other organizations.

Lecture Schedule
Theory

S.No.	Topic	Lectures
1.	Environment: Definition, scope and importance.	1*
2.	Natural Resources: Renewable and non-renewable resources	1*
3.	Forest resources: Use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forest and tribal people.	1*
4.	Water resources: Use and over-utilization of surface and ground water, floods, drought.	1*
5.	Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.	1*
6.	Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.	1*
7.	Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.	1*
8.	Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.	2*
9.	Ecology: Definition and scope. Ecosystems: Definition, concept, structure and function, components, producers, consumers and decomposers, Energy flow in the ecosystem.	3
10.	Ecological succession, Food chains, food webs and ecological pyramids.	2
11.	Introduction, types, characteristic features, structure and function of the following ecosystem: a. Forest ecosystem b. Grassland ecosystem c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	3
12.	Biodiversity and its conservation: Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India.	4
13.	Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.	3
14.	Threats to biodiversity. Conservation of biodiversity.	2
15.	Environmental Pollution: definition, cause, effects and control measures of: a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Thermal pollution g. Nuclear hazards.	3

16.	Solid Waste Management: causes, effects and control measures of urban and industrial wastes.	2*
17.	Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management.	2*
18.	Environmental ethics: Issues and possible solutions.	2*
19.	Wasteland reclamation. Consumerism and waste products.	2*
20.	Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act.	3
21.	Natural Disasters- Meaning and nature, types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.	3*
22.	Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents.	3*
23.	Disaster Management- Concept of disaster management, national disaster management framework; financial arrangements; Central, state, district and local administration; NGO, Armed forces in disaster response; Disaster response; Police and other organizations.	2*

Suggested Readings

1. Bamanayha B.R., Verma, L.N. and Verma A (2005). Fundamentals of Environmental Sciences, Yash Publishing House, Bikaner.
2. Dhaliwal G.S., Sangha G.S. and Ralhan P.K. (2000) Fundamentals of Environmental Sciences,Kalyani Publishers, New Delhi.
3. Odum E.P. and Barrett G.W.(2007) Fundamentals of Ecology, Akash Press, New Delhi.
4. Agrawal, K.C.(1999) Environmental Biology, Agro Botanica, Bikaner
5. Kumar, H.D.(1997) Modern concepts of Ecology, Vikash Publishing House Pvt. Ltd. New Delhi.
6. Dhaliwal G.S., and D.S.Kley (2006) Principles of Agricultural Ecology. Himalyan Publishing house, Bombay
7. Brij Gopal, and N.Bhardwaj (2004) Elements of Ecology. Vikash Publishing House, Pvt. Ltd., New Delhi.
8. Kudesta, V.P.(1990). Pollution Everywhere, Pragatgi Prakashan, Meerut
9. Nemeron, R.L.1976. Industrial Water Pollution. Addison Wesley

10. Mishra, P.C.(2001). Soil pollution and Soil Organism, Ashish Publishing House, 8/81, Punjab Bagh, New Delhi- 110026.

11.Pathak, H.and Kumar, S.,(2003). Soil and Green House Effect, CBS Publishers and Distributors, 4596/1-A, 11, Dayaganj, New Delhi – 10002.

ENTO-221	**Insect Ecology and Principles of Integrated Pest Management (New Course)**	**2(1+1)**

Theory

Part-I

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. Agroecosystem.

Part-II

Categories of insect pests. IPM: Introduction, history, importance, concept, principles and limitations of IPM. Economic decision levels. Survey, surveillance and forecasting of insect pests. Assessment of insect pest population. Tools/ methods of IPM: Cultural, mechanical, physical, legislative, host plant resistance, biological, and chemical control. Importance, hazards and limitations of chemical control. Classification, toxicity and formulations of insecticides. Insecticides Act 1968-Important provisions. Symptoms of poisoning, first aid and antidotes. Recent methods of pest control- repellents, antifeedants, hormones and pheromones, attractants, gamma radiation and genetic control.

Practical

Sampling techniques for estimation of insect population and damage. Monitoring of insect population through light and pheromone traps. Insecticides and their formulations. Pesticide appliances and their maintenance. Calculations on the doses of insecticides and application techniques. Safe use of pesticides. Ientification of biocontrol agents. Mass production of NPV and fungi.

Lecture Schedule
Theory

S.No.	Topic	Lectures
1.	**Insect Ecology:** Introduction, Environment and its components.	1
2.	Effect of abiotic factors–temperature, moisture, humidity, rainfall, light, atmospheric pressure and air currents.	1
3.	Effect of biotic factors – food competition, natural and environmental resistance. Agroecosystem.	1
4.	**IPM:** Categories of pests. Introduction, history, importance, concept, principles and limitations of IPM.	1

5.	Economic decision levels.	1
6.	Survey, surveillance and forecasting of insect pests. Assessment of insect pest population.	1
7.	Tools/ methods of IPM: Cultural, mechanical, physical, legislative, host plant resistance, biological.	3
8. 9.	Chemical control: Importance, hazards and limitations. Classification, toxicity and formulations of insecticides.	3
9.	Insecticides Act 1968-Important provisions.	1
10.	Application techniques of insecticides, symptoms of poisoning, first aid and antidotes.	1
11.	Recent methods of pest control- repellents, antifeedants, hormones and pheromones, attractants, gamma radiation and genetic control.	2

Practical

S.No.	Practical	Lectures
1.	Sampling techniques for estimation of insect population and damage.	2
2.	Monitoring of insect population through light and pheromone traps	1
3.	Insecticides and their formulations.	2
4.	Pesticide appliances: Handling and their maintenance of small kitchen garden sprayer, hand compression sprayer, knapsack sprayer, foot sprayer, power sprayer, hand rotary duster, power duster	4
5.	Calculations on the doses of insecticides	1
6.	Application techniques of insecticides.	1
7.	Safe use of pesticides	1
8.	Ientification of biocontrol agents	1
9.	Mass production of NPV and fungi	3

Suggested Readings

1. Yazdani G.S. and Agarwal M.L. 1979. Elements of Insect Ecology. Naroji publishing house.
1. Atwal, A.S. and Dhaliwal, G.S. 2002. Agricultural Pests of South Asia and Their Management, Kalyani Publishers, New Delhi.
2. David, B.V. and Ramamurthy, V.V. 2016. Elements of Economic Entomology, 8th Ed. Popular Book Depot, Chennai.
3. Dhaliwal, G.S. and Ramesh Arora 2001. Integrated Pest Management. Concepts and Approaches. Kalyani publishers, New Delhi.
4. Mathur and Upadhyay, 2005. A Text Book of Entomology, Aman Publishing House, Meerut.

5. Metcalf, R.L and Luckman W.H. 1982. Introduction to Insect Pest Management. Wiley Inter Science publishing, New York.
6. Srivastava, K.P. 2004. A Text Book of Entomology, Vol.I, Kalyani Publishers, New Delhi.
7. Dhawan, A.K. Integrated Pest Management, Scientic Publishers, Jodhpur.

ENTO-222	**Biopesticides and Biofertilizers (Elective course)**	**3(2+1)**

Theory

History and concept of biopesticides. Importance, scope and potential of biopesticide. Definitions, concepts and classification of biopesticides viz. pathogen, botanical pesticides and biorationales. Botanicals and their uses. Mass production technology of bio-pesticides. Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes. Methods of application of biopesticides. Methods of quality control and techniques of biopesticides. Impediments and limitations in production and use of biopesticide.

Biofertilizers: introduction, status and scope. Structure and characteristic features of bacterial biofertilizers: *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia;* cynobacterial biofertilizers: *Anabaena*, *Nostoc*, Hapalosiphon and fungal biofertilizers: AM mycorrhiza and ectomycorhiza. Nitrogen fixation: free living and symbiotic nitrogen fixation. Mechanism of phosphate solubilization and phosphate mobilization, K solubilization. Production technology: strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers. FCO specifications and quality control of biofertilizers. Application technology for seeds, seedlings, tubers, sets etc. Biofertilizers: storage, shelf life, quality control and marketing. Factors influencing the efficacy of biofertilizers.

Practical

Isolation and purification of important biopesticides: *Trichoderma Pseudomonas, Bacillus, Metarhyzium* etc. and its production. Identification of important botanicals. Visit to biopesticide laboratory in nearby area. Field visit to explore naturally infected cadavers. Identification of entomopathogenic entities in field condition. Quality control of biopesticides.

Isolation and purification of *Azospirillum* , *Azotobacter, Rhizobium*, P-solubilizers and cyanobacteria. Mass multiplication and inoculums production of biofertilizers. Isolation of AM fungi -Wet sieving method and sucrose gradient method. Mass production of AM inoculants.

Lecture Schedule: Theory

S.No.	Topic	No. of lectures
1	History and concept of biopesticides.	1
2	Importance, scope and potential of biopesticide.	1
3	Definitions, concepts and classification of biopesticides viz. pathogen, botanical pesticides and biorationales.	2
4	Botanicals and their uses.	1
5	Mass production technology of bio-pesticides.	4
6	Virulence, pathogenicity and symptoms of entomopathogenic pathogens and nematodes.	2
7	Methods of application of biopesticides.	1

8	Methods of quality control and techniques of biopesticides.	2
9	Impediments and limitations in production and use of biopesticide.	1
10	Biofertilizers: introduction, status and scope.	1
11	Structure and characteristic features of bacterial biofertilizers: *Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium* and *Frankia*;	2
12	Structure and characteristic features of cynobacterial biofertilizers- *Anabaena*, *Nostoc*,	1
13	Structure and characteristic features of Hapalosiphon and fungal biofertilizers: AM mycorrhiza and ectomycorhiza.	2
14	Nitrogen fixation: Free living and symbiotic nitrogen fixation.	2
15	Mechanism of phosphate solubilization and phosphate mobilization, K solubilization.	2
16	Production technology: strain selection, sterilization, growth and fermentation, mass production of carrier based and liquid biofertiizers.	3
17	FCO specifications and quality control of biofertilizers.	1
18	Application technology for seeds, seedlings, tubers, sets etc.	1
19	Biofertilizers: storage, shelf life, quality control and marketing.	1
20	Factors influencing the efficacy of biofertilizers.	1

Lecture Schedule: Practical

S.No.	Topic	No. of lectures
1	To study about mass production technology of important biopesticides: NPV, *Metarhyzium, Beauveria, Bt.* etc.	2
2	Identification of important botanicals. Preparation of plant extract: neem, karanj etc.	2
3	Visit to biopesticide laboratory in nearby area.	1
4	Field visit to explore naturally infected cadavers.	1
5	Identification of entomopathogenic entities in field condition.	1
6	Quality control of biopesticides.	1
7	Isolation and purification of important biopesticides: *Trichoderma Pseudomonas, Bacillus* and its production.	3
8	Isolation and purification of *Azospirillum, Azotobacter, Rhizobium* and P-solubilizers.	2
9	Mass multiplication and inoculum production of biofertilizers.	1
10	Isolation of AM fungi: wet sieving method and sucrose gradient method.	1
11	Mass production of AM inoculants.	1

References

1. Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.
2. Srivastava, K.P. 2004. A Text Book of Entomology, Vol. I, Kalyani Publishers, New Delhi.
3. Biswas, T.D. and Mukherjee, S.K. 1990. Text Book of Soil Sciences, Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. Mukherjee, N. and Ghosh T. 1998. Agricultural Microbiology, Kalyani Publishers, New Delhi.
5. Pelczar, Jr. Michel J. Chan, E.C.S. and Krieg, Noel R. 1997. Microbiology. Tata McGraw -Hill Edition, 1993. India.
6. Rangaswami, G. and Bagyaraj, D.J. 1993. Agricultural Microbiology. Prentice Hall of India Pvt. Limited, New Delhi.
7. Vishunavat, K. and Kolte, S.J. 2005. Essentials of Phytopathological Techniques. Kalyani Publishers, New Delhi
8. Cook RJ & Baker KF. 1983. The Nature and Practice of Biological Control of Plant Pathogens. APS, St Paul, Minnesota.
9. Campbell R. 1989. Biological Control of Microbial Plant Pathogens. Cambridge Univ. Press, Cambridge.
10. Mukerji KG, Tewari JP, Arora DK & Saxena G. 1992. Recent Developments in Biocontrol of Plant Diseases. Aditya Books, New Delhi.

ENTO-311	**Pests of Crops and Stored Grains and Their Management**	**4(3+1)**

Theory

Scientific name, order, family, distribution, identification, host range and nature of damage, biology and bionomics, and management of important arthropod pests.

Polyphagous insect pests: Locust, grasshopper, whitegrub, termite and red hairy caterpillar.

Pests of field crops: Cereals and millets- Rice: Brown plant hopper, yellow stem borer, rice hispa. Sorghum: Shootfly; Maize: Stem borer; Sugarcane: Pyrilla, whitefly, shoot borer. Pulses: Gram pod borer, cutworm. Tobacco: Tobacco caterpillar. Oilseeds: Mustard aphid, sawfly, painted bug, groundnut aphid, soybean girdle beetle, castor semilooper, castor capsule borer, sesame leaf and capsule borer. Cotton: Jassid, whitefly, spotted and pink bollworm, red cotton bug, mealy bug.

Pests of vegetables Brinjal- brinjal shoot and fruit borer; Tomato- Fruit borer (Covered in gram); Okra- Shoot and fruit borer (Covered in cotton). Potato: Tuber moth. Chilli: Thrips; Onion and garlic: Thrips. Cruciferous vegetables: Cabbage caterpillar, diamondback moth, semilooper, tobacco caterpillar (Covered in tobacco). Pea: Stem fly. Cucurbitaceous vegetables: Melon fruit fly, red pumpkin beetle, red vegetable mite.

Pests of fruit crops Mango: Mango hopper, mealy bug, stem borer, fruit fly; Guava: Fruit fly. Citrus: Citrus psylla, citrus caterpillar, bark eating caterpillar. Citrus: Citrus psylla, citrus caterpillar, bark eating caterpillar. Pomegranate: Anar butterfly; Ber: Fruit fly. Coconut: Black headed caterpillar; Apple: San Jose scale, woolly aphid.

Pests of ornamental crops: Rose aphid, hollyhock tinged bug, jasmine budworm.

Pests of spices and condiments: Aphid, seed midge.

Pests of stored grains: Khapra beetle, lesser grain borer, rice weevil, red rust flour beetle, pulse beetle, Angoumois grain moth, grain mite, storage fungi. Storage structures and methods of grain storage. Principles of stored grain pest management.

Rodents and their management in fields and godowns.

Birds of agricultural importance and their management.

Practical

Study of identification, host range and nature of damage, biology and bionomics, and management of important arthropod pests of various field crops, vegetable crops, fruit crops, ornamental crops, spices and condiments including polyphagous insect pests. Identification of insect pests and mtes associated with stored grains. Determination of insect infestation by different methods. Fumigation of grain stores and godowns. Identification of rodents and birds and their control operations. Determination of moisture content of grain. Methods of grain sampling under storage condition. Visit to nearest FCI godowns.

Lecture Schedule
Theory

S.No.	Topic	Lectures
1.	**Polyphagous insect pests:** Locust, grasshopper, whitegrub, termite and red hairy caterpillar	5
2.	Rice: Brown plant hopper, yellow stem borer, rice hispa. Wheat:: mite.	2
3.	Sorghum: Shootfly; Maize: Stem borer.	2
4.	Sugarcane: Pyrilla, whitefly, shoot borer.	1
5.	Pulses: Gram pod borer, cutworm. Tobacco: Tobacco caterpillar	2
6.	Oilseeds: Mustard aphid, sawfly, painted bug, groundnut aphid, soybean girdle beetle, castor semilooper, castor capsule borer, sesame leaf and capsule borer.	4
7.	Cotton: Jassid, whitefly, spotted and pink bollworm, red cotton bug, mealy bug.	3
8.	**Pests of vegetables crops:** Brinjal- brinjal shoot and fruit borer; Tomato- Fruit borer (Covered in gram); Okra- Shoot and fruit borer (Covered in cotton). Potato: Tuber moth. Pea: Stem fly.	2
9.	Chilli: Thrips; Onion and garlic: Thrips; Drum stick green caterpillar.	1
10.	Cruciferous vegetables: Cabbage caterpillar, diamondback moth, semilooper, tobacco caterpillar (Covered in tobacco).	3
11.	Cucurbitaceous vegetables: Melon fruit fly, red pumpkin beetle, red vegetable mite.	2
12.	**Pests of fruit crops:** Mango: Mango hopper, mealy bug, stem borer, fruit fly; Guava: Fruit fly.	3
13.	Citrus: Citrus psylla, citrus caterpillar, bark eating caterpillar.	2
14.	Pomegranate: Anar butterfly; Ber: Fruit fly, mite.	1

15.	Coconut: Black headed caterpillar; Apple: San Jose scale, woolly aphid.	2
16.	**Ornamental Crops:** Rose aphid, hollyhock tinged bug, jasmine budworm.	1
17.	**Spices and condiments:** Aphid, seed midge	1
18.	**Pests of stored grains:** Khapra beetle, lesser grain borer, rice weevil, red rust flour beetle, pulse beetle, Angoumois grain moth, grain mite, storage fungi.	4
20.	Rodents and their management in fields and godowns.	2
21.	Birds of agricultural importance and their management.	1
22.	Storage structures and methods of grain storage.	2
23.	Principles of stored grain pest management.	2

Practical

S.No.	Practical	Lectures
1.	Study of identification, host range and nature of damage, biology and bionomics, and management of important arthropod pests of various field crops: Polyphagous pests-Locust, grasshopper, whitegrub, termite and red hairy caterpillar	2
2.	Field crops Rice: Brown plant hopper, yellow stem borer, rice hispa Sorghum: Shootfly; Maize: Stem borer; Sugarcane: Pyrilla, whitefly, shoot borer Pulses: Gram pod borer, cutworm. Tobacco: Tobacco caterpillar Oilseeds: Mustard aphid, sawfly, painted bug, groundnut aphid, soybean girdle beetle, castor semilooper, castor capsule borer, sesame leaf and capsule borer. Cotton: Jassid, whitefly, spotted and pink bollworm, red cotton bug, mealy bug.	4
3.	**Vegetable crops:** Identification, host range and nature of damage, biology and bionomics, and management of important insect pests: Brinjal- brinjal shoot and fruit borer; Tomato- Fruit borer; Okra- Shoot and fruit borer; Potato: Tuber moth; Chilli: Thrips; Onion and garlic: Thrips; Cruciferous vegetables: Cabbage caterpillar, diamondback moth, semilooper, tobacco caterpillar; Pea: Stem fly; Cucurbitaceous vegetables: Melon fruit fly, red pumpkin beetle, red vegetable mite.	3
4.	**Pests of fruit crops:** Mango: Mango hopper, mealy bug, stem borer, fruit fly; Guava: Fruit fly; Citrus: Citrus psylla, citrus caterpillar, bark eating caterpillar; Pomegranate: Anar butterfly; Ber: Fruit fly.	2
5.	**Pests of stored grains:** Khapra beetle, lesser grain borer, rice weevil, red rust flour beetle, pulse beetle, Angoumois grain moth.	1
6	Rodents and their management in fields and godowns.	1
7	Birds of agricultural importance and their management.	1
8	Storage structures and methods of grain storage.	1
9.	Management of stored grain pests.	1

Suggested Readings

1. Atwal, A.S. and Dhaliwal, G.S. 2002. Agricultural Pests of South Asia and Their Management, Kalyani Publishers, New Delhi.
2. David, B.V. and Ramamurthy, V.V. 2016. Elements of Economic Entomology, 8th Ed. Popular Book Depot, Chennai.
3. Mathur and Upadhyay, 2005. A Text Book of Entomology, Aman Publishing House, Meerut.
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5. Srivastava, K.P. 2004. A Text Book of Entomology, Vol.I & II, Kalyani Publishers, New Delhi.
6. Reddy, P. Parvatha 2010. Insect, Mite and Vertebrate Pests and their Management in Horticultural Crops. Scientific Publishers, Jodhpur.

ENTO. 321 MANAGEMENT OF BENEFICIAL INSECTS 2(1+1)

Theory

Part - I

Beekeeping- Importance, bee species and biology, commercial methods of rearing, equipment used, seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication.

Sericulture- Importance, species of silkworm, voltinism and biology of silkworm. Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Rearing, mounting and harvesting of cocoons. Pests and diseases of silkworm.

Lac culture- Importance, species of lac insect, morphology, biology, host plants, lac production-seed lac, button lac, shellac, lac-products.

Part - II

Insect orders bearing parasitoids and predators used in pest control and their mass multiplication techniques. Important species of pollinators, weed killers and scavengers with their importance.

Practical

Honeybee species, castes of bees. Beekeeping appliances and seasonal management, bee enemies and disease. Bee pasturage, bee foraging and communication. Species of silkworm, voltinism of silkworm. Knowledge of mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves. Species of lac insect, host plant identification. Identification of other important pollinators, weed killers and scavengers. Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies. Identification and techniques for mass multiplication of natural enemies.

Lecture Schedule
Theory

S.No.	Topic	Lectures
1.	Beekeeping- Importance, bee species and biology.	2
2.	Commercial methods of rearing, equipment used, seasonal management.	1
3.	Bee enemies and diseases.	1
4.	Bee pasturage, bee foraging and communication.	1
5.	Importance, species of silkworm, voltinism and biology.	1
6.	Mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves.	1
7.	Rearing, mounting and harvesting of cocoons. Pest and diseases of silkworm.	1
8.	Importance, species of lac insect, morphology, biology, host plants, lac production- seed lac, button lac, shellac, lac- products.	2
9.	Insect orders bearing parasitoids and predators used in pest control.	2
10.	Mass multiplication techniques of parasitoids (*Trichogramma chilonis* and *Campoletis chloridae*) and predators (ladybird beetle).	3
11.	Important species of pollinators, weed killers and scavengers with their importance.	1

Practical

S.No.	Practical	Lectures
1.	Honey bee species, castes of bees.	1
2.	Beekeeping appliances and seasonal management, bee enemies and disease.	2
3.	Bee pasturage, bee foraging and communication.	1
4.	Types of silkworm, voltinism of silkworm.	1
5.	Knowledge of mulberry cultivation, mulberry varieties and methods of harvesting and preservation of leaves.	1
6.	Species of lac insect, host plant identification.	1
7.	Identification of important parasitoids, predators, pollinators, weed killers and scavengers.	1
8.	Collection of important parasitoids, predators, pollinators, weed killers and scavengers.	2
9.	Mass multiplication techniques of parasitoids (*Trichogramma chilonis* and *Campoletis chloridae*) and predators (ladybird beetle).	4
10.	Visit to research and training institutions devoted to beekeeping, sericulture, lac culture and natural enemies.	2

Suggested Readings

1. DeBach, P. 1974. Biological control by Natural enemies. Cambridge University Press.
2. Dhaliwal GS & Arora R. 2001. *Integrated Pest Management: Concepts and approaches.* Kalyani Publ., New Delhi.
3. Dhaliwal, GS & Koul O. 2007. *Biopesticides and Pest Management*. Kalyani Publ., New Delhi.
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6. Srivastava, K.P. 2004. A Text Book of Entomology, Vol. I, Kalyani Publishers, New Delhi.
7. Abrol, D.P. 2013. Beekeeping: A Comprehensive Guide to Bee and Beekeeping, Scientific Publishers, Jodhpur.

Extension Education–(Name to be rechristened as Agricultural Extension & Communication) - Annexures-VI (1) to VI (5)

1	EXCOM-111	Rural Sociology & Educational Psychology	2(2+0)
2	HVE-111	Human values and Ethics (non gradial)	1(1+0)**
3.	EXCOM-121	Fundamentals of Agricultural Extension Education	3(2+1)
4.	CSPD-121©	Communication Skills and Personality Development	2(1+1)
5	EDBC-311©	Entrepreneurship Development and Business Communication	2(1+1)

EXTENSION EDUCATION

EXCOM-111	**Rural Sociology & Educational Psychology**	**2 (2+0)**

Theory:

Sociology and Rural sociology: Definition and scope, its significance in agriculture extension, Social Ecology: Definition, objectives, history, challenges and social ecology in Indian context, Rural society: Important characteristics, differences & 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. Culture concept - Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions - Meaning, Definition and their role in Agricultural Extension. Social Institution: Meaning, Definition, Major institutions in Rural society, Functions., Social Change & Development: Meaning, Definition, Nature of Social change and factors of social change. Social process- Meaning, Definition, types. Social Control- - Meaning, Definition, Need and Means of Social control.. Rural Leadership: concept and definition, types and roles of leaders in rural context; Methods of selection of leaders.

Educational psychology: Meaning & its importance in agriculture extension. Behavior: Cognitive, affective, psychomotor domain, Cognitive skills, Personality- Meaning, Definition, Types, Factors influencing the

Personality and Role of Personality in Agricultural Extension., Motivation; Meaning , Definition, Importance in extension, Theories of Motivation, Intelligence-Meaning, Definition, Types, Factors affecting intelligence..Teaching Learning Process process- Meaning and Definition of Teaching, Learning, Learning experience and Learning situation, Elements of learning situation and its characteristics. Perception, Emotions.

Lecture Schedule

S.No	Course Content	No. of Lectures
	Theory	
1.	Sociology and Rural sociology: Definition and scope, its significance in agriculture extension,	1
2.	Social Ecology: Definition, objectives, history, challenges and social ecology in Indian context,	1
3.	Rural society: Important characteristics, differences & Relationship between Rural and Urban societies.,	1
4.	Social Groups: Meaning, Definition, Classification, Factors considered in formation and organization of groups.	2
5.	Social Stratification – Meaning, Definition, Functions, Forms of Social stratification.	2
6.	Culture concept - Culture, Customs, Folkways, Mores, Taboos, Rituals and Traditions - Meaning, Definition and their role in Agricultural Extension.	2
7.	Social Institution: Meaning, Definition, Major institutions in Rural society, Functions.,	2
8.	Social Change & Development: Meaning, Definition, Nature of Social change and factors of social change.	2
9.	Social process- Meaning, Definition, types.	2
10.	Social Control- - Meaning, Definition, Need and Means of Social control..	2
11.	Rural Leadership: concept and definition, types and roles of leaders in rural context; Methods of selection of leaders.	2
12.	Educational psychology: Meaning & its importance in agriculture extension.	1
13.	Behavior: Cognitive, affective, psychomotor domain, Cognitive skills,	2
14.	Personality- Meaning, Definition, Types, Factors influencing the Personality and Role of Personality in Agricultural Extension.	2
15.	Motivation; Meaning , Definition, Importance in extension, Theories of Motivation,	2

16.	Intelligence-Meaning, Definition, Types, Factors affecting intelligence.	2
17.	Teaching Learning Process - Meaning and Definition of Teaching, Learning, Learning experience and Learning situation, Elements of learning situation and its characteristics.,	3
18.	Perception, Emotions	1

Suggested readings

1. Chidambaram, J.B. 1973. Introductory rural sociology. New York, John Wilex and Sons.
2. Desai, A.R. 1978. Rural sociology in India. Bombay, Popular Prakashan, 5th Rev. ed.
3. Doshi, S.L. 2007. Rural sociology. Rawat Publishers, Delhi.
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6. Bhatia, H.R. 1965. A Text Book of Educational Psychology, Asia Publishing House, New Delhi.
7. Pujari, D. 2002. Educational Psychology in Agriculture, Agrotech Publishing Academy, Udaipur
8. Bhushan, V. and Sachdeva, D.R. 2010. An introduction to Sociology, Kitab Mahal , New Delhi.
9. Rao, C.N.S. 2015. Sociology, S.Chand & Company, New Delhi.
10. Maslow, A.H (1970) Motivation and personality. Harper and Row publishers , New York.

HVE-111	**Human Value and Ethics 1(1+0)**	**1 (1+0)**

Theory

Values and Ethics-An Introduction. Goal and Mission of Life. Vision of Life. Principles and Philosophy. Self Exploration. Self Awareness. Self Satisfaction. Decision Making. Motivation. Sensitivity. Success. Selfless Service. Case Study of Ethical Lives. Positive Spirit. Body, Mind and Soul. Attachment and Detachment. Spirituality Quotient. Examination

Lecture Schedule:

S. No.	**Course Content**	**No. of Lectures**
	Theory	
1.	Values and Ethics-An Introduction. Goal and Mission of Life.	2
2.	Vision of Life& Principles	1
3.	Self Exploration. Self Awareness. Self Satisfaction	2
4.	Decision Making	1
5.	Motivation.	1
6.	Sensitivity. Success. Selfless Service.	2
7.	Case Study of Ethical Lives.	2
8.	Positive Spirit. Body, Mind and Soul	2

9.	Attachment and Detachment	1
10.	Spirituality Quotient	1
11.	Examination	1

EXCOM-121	**Fundamentals of Agricultural Extension Education**	**3(2+1)**

Theory:

Education: Meaning, definition & Types; Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education; Extension Programme planning-Meaning, Process, Principles and Steps in Programme Development.

Extension systems in India: Extension efforts in Pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.). Post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.); Various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND,NATP, NAIP, NARP, ATIC,RKVY, Pradhan Mantri Fasal Bima Yojana, Soil Health Card, NRLM etc.)

New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc.. Rural Development: Concept, meaning, definition; various rural development programmes launched by Govt. of India. T & V System,SGSY, ICDS, IRDP, NHM,MNREGA, Rajiv Ganghi Scheme for empowerment of Adolesenct girls / Boys, Gramin Bhandaran Yojana, Pradhan Mantri Adarsh Gram yojana, Pradhan Mantri Kaushal Vikas yojana,

Community Development-meaning, definition, concept & principles, Philosophy of C.D, Panchayati Raj System.Extension administration: meaning and concept, principles and functions. Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes;Transfer of technology: concept and models, capacity building of extension personnel; Training: Types , planning a training Programme. Diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.

Practical

To get acquainted with university extension system. Group discussion- exercise; preparation and use of AV aids, preparation of extension literature – leaflet, booklet, folder, pamphlet news stories and success stories; A visit to village to understand the problems being encountered by the villagers/ farmers; to study organization and functioning of development departments at district level; visit to NGO and learning from their experience in rural development; understanding PRA techniques and their application in village development planning; exposure to mass media.

S. No.	**Course Content**	**No. of Lectur**

	Theory	**es**
1.	Education: Meaning, definition & Types;	**1**
2.	Extension Education- meaning, definition, scope and process; objectives and principles of Extension Education;	**3**
3.	Extension Programme planning- Meaning, Process, Principles and Steps in Programme Development.	**2**
4.	Extension systems in India: Extension efforts in Pre-independence era (Sriniketan, Marthandam, Firka Development Scheme, Gurgaon Experiment, etc.).	**3**
5.	Post-independence era (Etawah Pilot Project, Nilokheri Experiment, etc.);	**2**
6.	Various extension/ agriculture development programmes launched by ICAR/ Govt. of India (IADP, IAAP, HYVP, KVK, IVLP, ORP, ND,NATP, NAIP, NARP, ATIC,RKVY, Pradhan Mantri Fasal Bima Yojana, Soil Health Card, NRLM etc.)	**6**
7.	New trends in agriculture extension: privatization extension, cyber extension/ e-extension, market-led extension, farmer-led extension, expert systems, etc..	**3**
8.	Rural Development: Concept, meaning, definition; various rural development programmes launched by Govt. of India. ICDS, IRDP, NHM,MNREGA, Rajiv Gandhi Scheme for empowerment of Adolescent girls / Boys, Gramin Bhandaran Yojana, Pradhan Mantri Adarsh Gram yojana, Pradhan Mantri Kaushal Vikas yojana,	**5**
9.	Community Development-meaning, definition, concept & principles, Philosophy of C.D,	**1**
10.	Panchayati Raj System.	**1**
11.	Extension administration: meaning and concept, principles and functions.	**1**
12.	Monitoring and evaluation: concept and definition, monitoring and evaluation of extension programmes;	**1**
13	Transfer of technology: concept and models, capacity building of extension personnel;	**1**
14	Training: Types, planning training Programme.	**1**
15	Diffusion and adoption of innovation: concept and meaning, process and stages of adoption, adopter categories.	**1**
	Practical	
1.	To get acquainted with university extension system.	**1**
2.	Group discussion- exercise;	**1**
3.	Preparation and use of AV aids,	**4**
4.	Preparation of extension literature – leaflet, booklet, folder, pamphlet news	**4**

	stories and success stories;	
5.	A visit to village to understand the problems being encountered by the villagers/ farmers;	**1**
6.	To study organization and functioning of development departments at district level;	**1**
7.	Visit to NGO and learning from their experience in rural development;	**1**
8.	Understanding PRA techniques and their application in village development planning;	**2**
9.	Exposure to mass media.	**1**

Suggested readings

1. Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.
2. Dahama, O. P. and Bhatnagar, O. P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
3. Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
4. Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).
5. Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.
6. Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
7. Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
8. Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.
9. Debabrata Das Gupta. Extension Education. Agrobios (India), Agro house behind Nasrani Cinema, Chaupasani Road, Jodhpur- 342402, Phone -0291-2642319, Fax- 0291-2643993, Email- agrobios@sify.com
10. Sharma, O. P. & Somani, L. L. 2012. Dimension of Agricultural Extension, Agroteh Publishing Academy. Udaipur.

CSPD-121	**Communication Skills and Personality Development**	**2(1+1)**

Theory

Communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication. Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication; listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations, impromptu presentation, public speaking; Group discussion. Organizing seminars and conferences. Soft

Skills. Extension teaching methods: meaning, classification, individual, group and mass contact methods.ICT Applications in TOT (New and Social Media), media mix strategies;

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting; individual and group presentations. Handling and use of audio visual equipments and digital camera and LCD projector;Group discussion- exercise; Presentation skills exercise; micro teaching exercise; Script writing, writing for print and electronic media, developing script for radio and television.Visit to community radio.

Lecture Schedule:

S. No.	Course Content	No. of Lectures
	Theory	
1.	Communication: meaning and definition; Principles and Functions of Communication, models and barriers to communication.	**2**
2.	Communication Skills: Structural and functional grammar; meaning and process of communication, verbal and nonverbal communication;	**1**
3.	Listening and note taking,	**1**
4.	Writing skills, oral presentation skills;	**1**
5.	Field diary and lab record; indexing, footnote and bibliographic procedures.	**1**
6.	Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting;	**2**
7.	Individual and group presentations, impromptu presentation, public speaking;	**2**
8.	Group discussion. Organizing seminars and conferences.	**2**
9.	Soft Skills.	**1**
10.	Extension teaching methods: meaning, classification, individual, group and mass contact methods.	**2**
11.	ICT Applications in TOT (New and Social Media), media mix strategies;	**1**
	Practical	
1.	Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures.	**3**
2.	Reading and comprehension of general and technical articles,	**1**
3.	Precise writing, summarizing, abstracting; individual and group presentations.	**2**

4.	Handling and use of audio visual equipments and digital camera and LCD projector;	**4**
5.	Group discussion- exercise;	**1**
6.	Presentation skills exercise;	**1**
7.	Micro teaching exercise;	**1**
8.	Script writing, writing for print and electronic media, developing script for radio and television.	**2**
9.	Visit to community radio.	**1**

Suggested readings

1. Sandhu, A. S. (1999). Textbook on Agricultural Communication; process and methods oxford RIBH Publishing co. Pvt. Ltd. New Delhi.
2. Berlo, David K. (1960). The process of Communication. Nw Yark, Holt, Rinehart and Winston Inc.
3. Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.
4. Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.
5. Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.
6. Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.
7. M Hilaris 2011. Indian agriculture and information and communication technology (ICT): Soundari, New century Publications, Carnegie,
8. Dale. 2012. *How to Win Friends and Influence People in the Digital Age.* Simon & Schuster.
9. Covey Stephen R. 1989. *TheSeven Habits of Highly Successful People.* Free Press.
10. Verma, K.C. 2013. *The Art of Communication*. Kalpaz.
11. Mohan Krishna and Meera Banerjee. 1990. Developing Communication Skills. Macmillan India Ltd. New Delhi.
12. Sharma R C and Krishna Mohan. 1978. *Business Correspondence.* Tata Mc Graw Hill
13. Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.

EDBC-311	**Entrepreneurship Development and Business Communication**	**2 (1+1)**

Theory

Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs; SWOT Analysis & achievement motivation, Government policy and programs and institutions for entrepreneurship development, Impact of economic reforms on Agribusiness/ Agrienterprises, Entrepreneurial Development Process; Business Leadership Skills; Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation), Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills), Problem solving skill, Supply chain management and Total quality

management, Project Planning Formulation and report preparation; Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise.

Practical

Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation, exercise in creativity, time audit through planning, monitoring and supervision, identification and selection of business idea, preparation of business plan and proposal writing, visit to entrepreneurship development institute and entrepreneurs.

Lecture Schedule:

S. No.	Course Content	No. of Lectures
	Theory	
1.	Concept of Entrepreneur, Entrepreneurship Development, Characteristics of entrepreneurs;	1
2.	SWOT Analysis & achievement motivation,	1
3.	Government policy and programs and institutions for entrepreneurship development,	2
4.	Impact of economic reforms on Agribusiness/ Agrienterprises,	1
5.	Entrepreneurial Development Process;	1
6.	Business Leadership Skills;	1
7.	Developing organizational skill (controlling, supervising, problem solving, monitoring & evaluation),	2
8.	Developing Managerial skills, Business Leadership Skills (Communication, direction and motivation Skills),	2
9.	Problem solving skill, Supply chain management and Total quality management,	2
10.	Project Planning, Formulation and report preparation;	2
11.	Financing of enterprise, Opportunities for agri-entrepreneurship and rural enterprise.	1
	PRACTICAL	
1	Assessing entrepreneurial traits, problem solving skills, managerial skills and achievement motivation,	4
2	Exercise in creativity, time audit through planning, monitoring and supervision,	4
3	Identification and selection of business idea,	2
4	Preparation of business plan and proposal writing,	2
5	Visit to entrepreneurship development institute and entrepreneurs.	4

Suggested readings

1. Harold Koontz & Heinz Weihrich. 2004. *Essentials of Management: An International Perspective,* 2nd Ed. Tata Mc-Graw Hill Publishing Pvt Ltd.
2. Chole, R. R. Kapse, P. S. and Deshmukh, P. R. 2012. Entrepreneurship Development and Communication Skills scientific Publisher (India), Jodhpur.
3. Bhaskaran, S. 2014. Entrepreneurship Development and Management. Aman Publishing House, Meerut.
4. Mancuso, J. 1974. The Entrepreneurs Handbook (Vol. 192(, Artech House, Inc., USA.
5. Karthikeyan,C. et al. 2008.. A Text Book of Agricultural Extension Management. Atlantic Publishers, New Delhi.
6. Natrajan,K. and Ganeshan, K.P. 2012.Principles of Management. Himalaya Publishing House, New Delhi.
7. Balasubrmanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.
8. Dipak De & Basavaprabhu Jirli. *Entrepreneurship : Theory and practice in agriculture.* ISBN 81-85694-57-5, Ganga Kaveri Publishing House, D.35/77, Jangamawadimath, Varanasi-221001 (India), Ph.-0542-2451936
9. Mukesh Pandey & Deepali Tewari. 2010. *The Agribusiness Book.* IBDC Publishers.
10. Nandan H. 2011. *Fundamentals of Entrepreneurship.* PHI Learning Pvt Ltd India.
11. Poornima Charantimath. 2006. *Entrepreneurship Development: Small Business Enterprise.* Pearson Education.
12. Harsh, S.B., Conner, U.J. and Schwab, G.D. 1981. *Management of the Farm Business.* Prentice Hall Inc., New Jersey.
13. Joseph, L. Massie. 1995. *Essentials of Management.* Prentice Hall of India Pvt. Ltd., New Delhi.
14. Omri Rawlins, N. 1980. *Introduction to Agribusiness.* Prentice Hall Inc., New Jersey
15. Thomas W Zimmer and Norman M Scarborough. 1996. *Entrepreneurship.* Prentice-Hall, New Jersey.
16. Mark J Dollinger. 1999. *Entrepreneurship Strategies and Resources.* Prentice-Hall, Upper Saddal Rover, New Jersey.
17. Khanka S S. 1999. *Entrepreneurial Development.* S. Chand and Co. New Delhi.
18. Mohanty S K. 2007. *Fundamentals of Entrepreneurship*. Prentice Hall India Ltd., New Delhi.

Horticulture - Annexures-VII (1) to VII (8)

1	HORT-111	Fundamentals of Horticulture	2(1+1)
2	HORT-112	Introduction to Forestry	2(1+1)
3	HORT-211	Production Technology for Vegetables and Spices	2(1+1)
4	HORT-221	Production Technology for Ornamental Crops, MAP and Landscaping	2(1+1)
5	HORT-222	Production Technology for Fruit and Plantation Crops	2(1+1)
6.	HORT-311	Landscaping (Elective course)	3(2+1)
7.	HORT-321	Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)
8.	HORT-322	Principles of Food Science & Nutrition	2(2+0)

HORTICULTURE

HORT-111	Fundamentals of Horticulture	2(1+1)

Theory

Horticulture - Its definition and branches, importance and scope; horticultural and botanical classification; climate and soil for horticultural crops; Plant propagation-methods and propagating structures; Seed dormancy, Seed germination, principles of orchard establishment; Principles and methods of training and pruning, juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy; medicinal and aromatic plants; importance of plant bio-regulators in horticulture. Irrigation – methods, Fertilizer application in horticultural crops.

S.N.	Name of Topic	Cr Hrs
1.	Horticulture - Its definition and branches, importance and scope	**1**
2.	Horticultural and botanical classification	**1**
3.	Climate and soil for horticultural crops	**1**
4.	Nursery raising and its importance	**1**
5.	Plant propagation-methods	**2**
6.	Propagating structures	**1**
7.	Seed dormancy and Seed germination	**1**
8.	Principles of orchard establishment	**2**
9.	Principles and Methods of training and pruning	**1**
10.	Juvenility and flower bud differentiation; unfruitfulness; pollination, pollinizers and pollinators; fertilization and parthenocarpy	**1**
11.	Medicinal and Aromatic plants- importance and scope	**2**
12.	Importance of plant bio-regulators in horticulture	**1**
13.	Irrigation – methods, Fertilizer application in horticultural crops	**1**

Practical (Fundamentals of Horticulture)**:**

Identification of garden tools. Identification of horticultural crops. Preparation of seed bed/nursery bed. Practice of sexual and asexual methods of propagation including micro-propagation. Layout and planting of orchard. Training and pruning of fruit trees. Preparation of potting mixture. Fertilizer application in different crops. Visits to commercial nurseries/orchard.

S.N.	Name of Topic	Cr Hrs
1.	Identification of Horticultural crops	**1**
2.	Identification of garden tools	**1**
3.	Preparation of seed bed/nursery bed	**1**
4.	Practice of sexual and asexual methods of propagation	**3**
5.	Micro-propagation	**1**
6.	Layout and planting of orchard	**2**
7.	Training and pruning of fruit trees	**1**
8.	Preparation of potting mixture	**1**
9.	Fertilizer application in different crops	**1**
10.	Layout and components of a model nursery	**2**
11.	Visits to commercial nurseries/orchard	**2**

Reference Books (Fundamentals of Horticulture)**::**

S. no.	Title of Book	Author	Publisher
1	Handbook of Horticulture (2002)	Chadha, K.L.	ICAR, NewDelhi
2	A handbook of Fruit Science and Technology (2013)	D.K. Salunkhe and S.S. Kadam	CRC Press
3	Basic Horticulture (2011)	Jitendra Singh	Kalyani Publications, New Delhi
4	Basics Horticulture (2009)	K.V.Peter	New India Publishing Agency
5	Fundamentals of Horticulture2014	Kausal Kumar Misra and Rajesh Kumar	Biotech Books
6	Introduction to Horticulture (1990)	Kumar, N.	Rajyalakshmi publications, Nagarcoil, Tamilnadu
7	Basic concepts of Fruit Science (2005)	Neeraj Pratap Singh	IBDC Publishers
8	Principles of Horticulture 2nd Edn. 2014	Prasad and Kumar	Agrobios (India)
9	A handbook of Fruit Production (2010)	S. Prasad and U. Kumar	Agrobios (India)
10	Precision farming	Singh Jitender	NIPA
11	Advances in Horticulture	Singh, H.P.	Westville

	Biotechnology Vol.-7: Diagnostics for Horticulture crops		
12	Advances in horticulture Biotechnology, Vol-1: Fruit Crops	Singh, H.P.	Westville
13	Ethnobotany: A recent approach	Kapoor, B.	Madhu
14	Plant Growth Regulators in Agriculture & Horticulture: Their Role and commercial use	Basra, A.S.	IBD
15	Precision Farming in Horticulture: Approaches and Strategies	Swain, S.	NPH
16	Biometrical methods in Horticultural Sciences	Sharma, N.	NIPA

HORT-112	**Introduction to Forestry**	**2(1+1)**

Theory

Introduction – definitions of basic terms related to forestry, objectives of silviculture, forest classification, salient features of Indian Forest Policies. Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers; Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations. Crown classification. Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning. Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement - shadow and single pole method; Instrumental methods of height measurement - geometric and trigonometric principles, instruments used in height measurement; tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees. Agroforestry – definitions, importance, criteria of selection of trees in agroforestry, different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens. Cultivation practices of two important fast growing tree species of the region.

S.N.	Name of Topic	Cr Hrs
1	Introduction – definitions of basic terms related to forestry, objectives of silviculture, forest classification, salient features of Indian Forest Policies.	**2**
2	Forest regeneration, Natural regeneration - natural regeneration from seed and vegetative parts, coppicing, pollarding, root suckers;	**2**
3	Artificial regeneration – objectives, choice between natural and artificial regeneration, essential preliminary considerations.	**2**
4	Crown classification.	**1**
5	Tending operations – weeding, cleaning, thinning – mechanical, ordinary, crown and advance thinning.	**2**

6	Forest mensuration – objectives, diameter measurement, instruments used in diameter measurement; Non instrumental methods of height measurement - shadow and single pole method; Instrumental methods of height measurement - geometric and trigonometric principles, instruments used in height measurement; tree stem form, form factor, form quotient, measurement of volume of felled and standing trees, age determination of trees.	**3**
7	Agroforestry – definitions, importance,	**1**
8	Criteria of selection of trees in agroforestry,	**1**
9	Different agroforestry systems prevalent in the country, shifting cultivation, taungya, alley cropping, wind breaks and shelter belts, home gardens.	**1**
10	Cultivation practices of two important fast growing tree species of the region.	**1**

Practical (Introduction to Forestry):

Identification of tree-species. Diameter measurements using calipers and tape, diameter measurements of forked, buttressed, fluted and leaning trees. Height measurement of standing trees by shadow method, single pole method and hypsometer. Volume measurement of logs using various formulae. Nursery lay out, seed sowing, vegetative propagation techniques. Forest plantations and their management. Visits of nearby forest based industries.

S.N.	Name of Topic	Cr Hrs
1	Identification of tree-species.	**1**
2	Diameter measurements using calipers and tape,	**2**
3	diameter measurements of forked, buttressed, fluted and leaning trees.	**2**
4	Height measurement of standing trees by shadow method, single pole method and hypsometer.	**2**
5	Volume measurement of logs using various formulae.	**2**
6	Nursery lay out, seed sowing, vegetative propagation techniques.	**4**
7	Forest plantations and their management.	**2**
8	Visits of nearby forest based industries.	**1**

HORT-211	**Production Technology for Vegetables and Spices**	**2(1+1)**

Theory

Importance of vegetables & spices in human nutrition and national economy, kitchen gardening, brief about origin, area, climate, soil, improved varieties and cultivation practices such as time

and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices (Tomato, Brinjal, Chilli, Capsicum, Cucumber, Melons, Gourds, Pumpkin, French bean, Peas; Cole crops such as Cabbage, Cauliflower, Knol-khol; Bulb crops such as Onion, Garlic; Root crops such as Carrot, Radish, Beetroot; Tuber crops such as Potato; Leafy vegetables such as Amaranth, Palak. Perennial vegetables.

S.N.	Name of Topic	Cr Hrs
1.	Importance of vegetables & spices in human nutrition and national economy	**1**
2.	Classification of Vegetables	**1**
3.	Types of vegetable gardening with special reference to kitchen gardening	**1**
4.	Brief about origin, area, climate, soil, improved varieties and cultivation practices such as time and methods of sowing, transplanting techniques, planting distance, fertilizer requirements, irrigation, weed management, harvesting and yield, physiological disorders, of important vegetable and spices: Tomato,	**1**
5.	Brinjal, Chilli, Capsicum,	**1**
6.	Cucumber, Melons, Gourds, Pumpkin,	**1**
7.	French bean, Peas and Okra	**1**
8.	Cole crops such as Cabbage, Knol-khol, Cauliflower	**1**
9.	Bulb crops such as Onion and Garlic	**1**
10.	Root crops such as Carrot, Radish, Beet-root	**1**
11.	Tuber crops such as Potato and Sweet potato	**1**
12.	Leafy vegetables such as Amaranthus and Palak	**1**
13.	Perennial vegetables such as drumstick and pointed gourd	**1**
14.	Seed spices: Coriander, cumin, fenugreek & fennel	**1**
15.	Black pepper and Cardamom	**1**
16.	Turmeric & Ginger	**1**

Practical (Production Technology for Vegetable and Spices)**:**

Identification of vegetables & spice crops and their seeds. Nursery raising. Direct seed sowing and transplanting. Study of morphological characters of different vegetables & spices. Fertilizers applications. Harvesting & preparation for market. Economics of vegetables and spices cultivation.

S.N.	Name of Topic	Cr Hrs
1.	Identification of Vegetables & Spice crops and their seeds	**1**
2.	Nursery raising, Direct seed sowing and Transplanting	**1**
3.	Study of morphological characters of different vegetables & spices Solanaceous crops (Tomato, Brinjal, Capsicum)	**1**
4.	Cucurbitaceous crops	**1**
5.	Bulb crops	**1**
6.	Beans, Pea and Okra	**1**
7.	Root crops	**1**
8.	Tuber crop (Potato and Sweet Potato)	**1**
9.	Leafy vegetables	**1**
10.	Seed spices	**1**
11.	Black pepper and Cardamom	**1**
12.	Ginger and Turmeric	**1**
13.	Fertilizers applications	**1**
14.	Harvesting & preparation for market	**1**
15.	Economics of vegetables and spices cultivation	**2**

Reference Books (Production Technology for Vegetable and Spices):

S. no.	Title of Book	Author	Publisher
1	A Text book on production technology of vegetables (2009)	B.R.Choudhary	Kalyani Publishers
2	Vegetable crops in India (2008)	K S Yawalkar	Agri-Horticultural Pub. House. Nagpur
3	Vegetable Crop Production (2007)	K.V.Kamath	Oxford Book Company
4	Olericulture in India (2008)	M.K.Rana	Kalyani Publishers
5	Handbook of Vegetable Crops (2008)	M.S.Dhaliwal	Kalyani Publishers
6	Vegetables for the Tropical Regions (1994)	Nath Prem	ICAR New Delhi
7	Modern Technology in Vegetable Production (2011)	P.Hazra	New India Publishing Agency, New Delhi
8	Major Spices of India- Crop	Pruthi, J.S	ICAR

	Management Postharvest Technology (1993)		
9	Minor Spices of India- Crop Management Postharvest Technology (2001)	Pruthi, J.S	ICAR
10	Text book of vegetable, tuber crops and Spices (2014)	S. Thamburaj	ICAR
11	Production technology of spices and plantation crops (2005)	Shanmugavelu, K.G. Kumar, N and Peter, K.V	Agrosis, Jodhpur
12	Modern Vegetable varieties and production (2007)	Singh, D.K.	IBN publishers, Technology International Book Distributing Co, Lucknow
13	Indian Vegetables (2008)	Singh, Umashankar	Anmol Publications. Pvt.Ltd .New Delhi
14	Vegetable Crops (2002)	T.K.Bose	Nayaprakash, Kolkata
15	Vegetable Crops (2007)	T.R.Gopal Krishnan	New India Publishing Agency. New Delhi
16	Winter Vegetables: Advances & Developments	D.N. Singh etal.	Satish Serial Pub. House
17	Breeding of Vegetable crops	Ramchandra R.K.	Jaya Publishing House
18	Practicals on Vegetable Production Technology	Sharma & Katoch	Jaya Publishing House
19	Diseases of Vegetable crops and their integrated management: A colour handbook	Mishra, R.	NIPA
20	Seeds Production: Vegetables & Root Crops	Boswell, V.R.	ISPG

HORT-221	**Production Technology for Ornamental Crops, MAP and Landscaping**	**2(1+1)**

Theory

Importance and scope of ornamental crops, medicinal and aromatic plants and landscaping. Principles of landscaping. Landscape uses of trees, shrubs and climbers. Production technology of important cut flowers like rose, gerbera, carnation, lilium and orchids under protected conditions and gladiolus, tuberose, chrysanthemum under open conditions. Package of practices for loose flowers like marigold and jasmine under open conditions. Production technology of

important medicinal plants like ashwagandha, asparagus, aloe, costus, Cinnamomum, periwinkle, isabgol and aromatic plants like mint, lemongrass, citronella, palmarosa, ocimum, rose, geranium, vetiver. Processing and value addition in ornamental crops and MAPs produce.

S.N.	Name of Topic	Cr Hrs
1.	Importance and scope of ornamental crops, medicinal and aromatic plants	**1**
2.	Importance and scope landscaping and Principles of landscaping	**1**
3.	Landscape uses of trees, shrubs and climbers	**1**
4.	Production technology of important cut flowers like rose	**1**
5.	Gerbera and carnation under protected conditions	**2**
6.	Gladiolus, tuberose, chrysanthemum under open conditions	**2**
7.	Package of practices for loose flowers like marigold and jasmine under open conditions	**1**
8.	Production technology of important medicinal plants like ashwagandha, asparagus, safed musli	**1**
9.	Aloe, Cinnamon, periwinkle, isabgol	**1**
10.	Aromatic plants like mint, lemongrass	**1**
11.	Citronella, palmarosa	**1**
12.	Ocimum, rose	**1**
13.	Geranium, vetiver	**1**
14.	Processing and value addition in ornamental crops and MAPs produce	**1**

Practical (Production Technology for Ornamental Crops, MAPs and Landscaping)**:**

Identification of Ornamental plants. Identification of Medicinal and Aromatic Plants. Nursery bed preparation and seed sowing. Training and pruning of Ornamental plants. Planning and layout of garden. Bed preparation and planting of MAP. Protected structures – care and maintenance. Intercultural operations in flowers and MAP. Harvesting and post harvest handling of cut and loose flowers. Processing of MAP. Visit to commercial flower/MAP unit.

S.N.	Name of Topic	Cr Hrs
1.	Identification of Ornamental plants	**1**
2.	Identification of Medicinal and Aromatic Plants	**1**
3.	Nursery bed preparation and seed sowing	**1**

4.	Propagation of Ornamental and MAPs	**2**
5.	Training and pruning of Ornamental plants	**2**
6.	Planning and layout of garden. Bed preparation and planting of MAP	**2**
7.	Protected structures – care and maintenance	**1**
8.	Intercultural operations in flowers and MAP	**1**
9.	Harvesting and post harvest handling of cut and loose flowers. Processing of MAP	**3**
10.	Visit to commercial flower and MAP unit	**2**

Reference Books (Production Technology for Ornamental Crops, MAPs and Landscaping)**:**

S. no.	**Title of Book**	**Author**	**Publisher**
1	Fundamentals of ornamental horticulture and landscape gardening (2012)	A.K. Tiwari and R. Kumar	New India
2	Introductory Ornamental Horticulture (2006)	Arora, J.S.	Kalyani Publishers
3	Cultivation and Utilization of Medicinal and Aromatic plants (1982)	Atal, E.K. and Kapur, B.	CSIR, New Delhi
4	Cultivation of medicinal and aromatic plants (2001)	Azhar Ali Farooqui and Sreeramu, B.S.	United Press Limited
5	Flowering Garden trees (2014)	Bimaldas Chowdhury and Balai Lal Jana	Pointer publishers, Jaipur
6	Floriculture and Landscaping (2004)	Bose, T.K. Malti, R.G. Dhua, R.S. & Das, P.	Nayaprakash
7	Gardening in India (2004)	Bose, T.K. and Mukherjee, D.	Oxford & IBH Publishers
8	Ornamental Horticulture in India (1986)	Chadha, K.L. and Chaudhary, B.	ICAR
9	Landscape designing and ornamental plants (2014)	H.S.Grewal and Parminder Singh	
10	Ornamental plants (2009)	K.V.Peter.	New India publishing agency
11	Fundamentals of Garden designing (2013)	R.K. Roy	New India publishing agency

12	Fundamentals of Garden designing (2014)	Rajesh Srivastava	Agrotech press, Jaipur
13	Floriculture in India (2004)	Randhawa, G.S. Amitabha Mukhopadhyay	Allied Publishers Pvt. Ltd., New Delhi
14	Fundamentals of Ornamental Horticulture and Landscaping Gardening	Tiwari, A.K.	NIPA
15	Agrotechniques and Uses of Medicinal Plants	Gupta, R.D.	Astral
16	Complete Encyclopedia of House Plants: A comprehensive cross reference guide to popular house plant	Vermeulin, N.	Rebo

HORT-222	**Production Technology for Fruit and Plantation Crops**	**2(1+1)**

Theory

Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks; Production technologies for the cultivation of major fruits-mango, banana, citrus, grape, guava, litchi, papaya, sapota, apple, pear, peach, walnut, almond and; minor fruits- date, ber, pineapple, pomegranate, jackfruit, strawberry, plantation crops-coconut, arecanut, cashew, tea, coffee & rubber.

S.N.	Name of Topic	Cr Hrs
1.	Importance and scope of fruit and plantation crop industry in India; Importance of rootstocks	**1**
2.	Production technologies for the cultivation of major fruits - Mango	**1**
3.	Banana	**1**
4.	Citrus	**1**
5.	Grape	**1**
6.	Guava and Litchi	**1**
7.	Papaya and Sapota	**1**
8.	Apple	**1**
9.	Pear and Peach	**1**
10.	Walnut and Almond	**1**

11.	Minor fruits- Date palm, Ber, Aonla, Custard apple, Bael and Strawberry	**2**
12.	Pineapple and Pomegranate	**1**
13.	Plantation crops-Coconut and Cashew nut	**1**
14.	Areca nut & Rubber	**1**
15.	Tea and Coffee	**1**

Practical (Production Technology for Fruit and Plantation Crops)**:**

Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops. Description and identification of fruit. Preparation of plant bio regulators and their uses, Important pests, diseases and physiological disorders of above fruit and plantation crops, Visit to commercial orchards.

S.N.	Name of Topic	Cr Hrs
1	Description and identification of fruit	**1**
2	Seed propagation. Scarification and stratification of seeds. Propagation methods for fruit and plantation crops	**3**
3	Layout and planting of fruits and plantation crops	**2**
4	Preparation of plant bio regulators and their uses	**1**
5	Important pests of fruits and plantation crops	**1**
6	Important diseases of fruits and plantation crops	**1**
	Important physiological disorders of fruits and plantation crops	**2**
7	Fertilizer application in fruits and plantation crops	**1**
8	Irrigation methods in fruits and plantation crops	**1**
9	Training and pruning of fruits and plantation crops	**1**
10	Weed management in fruits and plantation crops	**1**
11	Visit to commercial orchards	**1**

Reference Books (Production Technology for Fruit and Plantation Crops)**:**

S. no.	Title of Book	Author	Publisher
1	Fruit Growing (2010)	Bal, J.S.	Kalyani Publishers
2	Advances in Temperate Fruit Production (2010)	Banday F.A. and Sharma M.K.	Kalyani Publishers

3	Tropical and Sub-Tropical-Vol-I (2002)	Bose, T.K., Mitra, S.K. and Sanyal, D.	Nayaprakash, Kolkata
4	Text Book of Temperate Fruits (2001)	Chadha, T.R	ICAR Publication
5	A text book on Pomology-IV Devoted to Temperate fruits (2009)	Chattopadhyay T.K.	Kalyani Publishers
6	Cultivation of Minor Fruits	Das B.C and Das S.N .	Kalyani Publishers
7	Advanced in Horticulture (2009)	K.L.Chadda	Malhotra Publishing House, New Delhi
8	Introduction to spices, Plantation crops and Aromatic plants (1997)	Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I.	Oxford & IBH, New Delhi
9	Fruit crops (2007)	Radha T and Mathew L.	New India Publishing Agency
10	Commercial fruits (2004)	S.P. Singh	Kalyani Publishers
11	Fruit Production in India (2013)	W S Dhillon	Narendra Publishing House
12	Tropical & Sub-tropical Fruit Crops: Crop Improvement and varietal Wealth- 2 parts	S.N. Ghosh	Jaya Publishing House
13	Temperate Fruit Breeding	Ghosh, Verma Thakur	Jaya Publishing House
14	Breeding of underutilized Fruit crops	S.N. Ghosh	Jaya Publishing House
15	Breeding of Fruit Crops	Ramchandra etal	Jaya Publishing House
16	Fruit Breeding	Dinesh, M.R.	NIPA
17	Upto Date Fruit Science	Bikash Ghosh, Sayan Sau	Jaya Publishing House
18	Fruit tree Physiology	Dhillon/Bhatt	Jaya Publishing House
19	Disease management of Fruit crops	Rathore, G.S.	ATPA

HORT-311	Landscaping (Elective course)	3(2+1)

Theory

Importance and scope of landscaping. Principles of landscaping, garden styles and types, terrace gardening, vertical gardening, garden components, adornments, lawn making, rockery, water garden, walk-paths, bridges, other constructed features etc. gardens for special purposes. Trees: selection, propagation, planting schemes, canopy management, shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture. Climber and creepers: importance, selection, propagation, planting, Annuals: selection, propagation, planting scheme, Other garden plants: palms, ferns, grasses and cacti succulents. Pot plants: selection, arrangement, management. Bio-aesthetic planning: definition, need, planning; landscaping of urban and rural areas, Peri-urban landscaping, Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions. Bonsai: principles and management, lawn: establishment and maintenance. CAD application.

S.N.	Name of Topic	Cr Hrs
1.	Importance and scope of landscaping	**1**
2.	Principles of landscaping	**2**
3.	Garden styles and types	**3**
4.	Terrace gardening	**1**
5.	Vertical gardening	**1**
6.	Garden components	**1**
7.	Garden adornments	**1**
8.	Rockery	**1**
9.	Water garden	**1**
10.	Walk-paths, bridges, other constructed features etc. gardens for special purposes	**1**
11.	Trees: selection, propagation, planting schemes, canopy management	**1**
12.	Shrubs and herbaceous perennials: selection, propagation, planting schemes, architecture	**1**
13.	Climber and creepers: importance, selection, propagation, planting	**1**
14.	Annuals: selection, propagation, planting scheme	**1**
15.	Other garden plants: palms, ferns, grasses, cacti succulents and shade loving plants	**2**
16.	Pot plants: selection, arrangement, management	**1**

17.	Bio-aesthetic planning: definition, need, planning	**2**
18.	Landscaping of urban and rural areas	**1**
19.	Peri-urban landscaping (roof garden)	**1**
20.	Landscaping of schools, public places like bus station, railway station, townships, river banks, hospitals, play grounds, airports, industries, institutions	**2**
21.	Bonsai: principles and management	**2**
22.	Lawn: establishment and maintenance	**2**
23.	CAD application	**2**

Practical (Landscaping) **:**

Identification of trees, shrubs, annuals, pot plants; Propagation of trees, shrubs and annuals, care and maintenance of plants, potting and repotting, identification of tools and implements used in landscape design, training and pruning of plants for special effects, lawn establishment and maintenance, layout of formal gardens, informal gardens, special type of gardens (sunken garden, terrace garden, rock garden) and designing of conservatory and lath house. Use of computer software, visit to important gardens/ parks/ institutes.

S.N.	Name of Topic	Cr Hrs
1.	Identification of trees, shrubs, annuals, pot plants	**2**
2.	Identification of tools and implements used in landscape design	**1**
3.	Propagation of trees, shrubs and annuals	**2**
4.	Care and maintenance of plants, **shrubs and trees**	**1**
5.	Potting and repotting	**1**
6.	Training and pruning of plants for special effects	**1**
7.	Lawn establishment and maintenance	**1**
8.	Layout of formal gardens	**1**
9.	Layout of informal gardens	**1**
10.	Layout of special type of gardens (sunken garden, terrace garden, rock garden)	**2**
11.	Designing of conservatory and lath house	**1**
12.	Use of computer software	**1**
13.	Visit to important gardens/ parks/ institutes	**1**

HORT-321	Post-harvest Management and Value Addition of Fruits and Vegetables	2(1+1)

Theory

Importance of post-harvest processing of fruits and vegetables, extent and possible causes of post harvest losses; Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening; Respiration and factors affecting respiration rate; Harvesting and field handling; Storage (ZECC, cold storage, CA, MA, and hypobaric); Value addition concept; Principles and methods of preservation; Intermediate moisture food- Jam, jelly, marmalade, preserve, candy – Concepts and Standards; Fermented and non-fermented beverages. Tomato products- Concepts and Standards; Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying. Canning -– Concepts and Standards, packaging of products.

S.N.	Name of Topic	Cr Hrs
1.	Importance of post-harvest processing of fruits and vegetables	**1**
2.	Extent and possible causes of post harvest losses	**1**
3.	Pre-harvest factors affecting postharvest quality, maturity, ripening and changes occurring during ripening	**1**
4.	Respiration and factors affecting respiration rate	**1**
5.	Maturity indices**,** Harvesting and field handling	**1**
6.	Storage (ZECC, cold storage, CA, MA, and hypobaric)	**1**
7.	Value addition concept; Principles and methods of preservation	**2**
8.	Intermediate moisture food- Jam, jelly, marmalade	**1**
9.	Preserve, candy – Concepts and Standards	**1**
10.	Fermented and non-fermented beverages	**2**
11.	Tomato products- Concepts and Standards	**1**
12.	Drying/ Dehydration of fruits and vegetables – Concept and methods, osmotic drying	**1**
13.	Canning -– Concepts and Standards, packaging of products	**2**

Practical (Post-harvest Management and Value Addition of Fruits and Vegetables) :

Applications of different types of packaging, containers for shelf life extension. Effect of temperature on shelf life and quality of produce. Demonstration of chilling and freezing injury in vegetables and fruits. Extraction and preservation of pulps and juices. Preparation of jam, jelly, RTS, nectar, squash, osmotically dried products, fruit bar and candy and tomato products, canned products. Quality evaluation of products -- physico-chemical and sensory. Visit to processing unit/ industry.

S.N.	Name of Topic	Cr Hrs
1.	Identification and applications of different types of packaging, containers for shelf life extension	**1**
2.	Identification of important tools/equipments/ machines and chemicals required for PHT laboratory	**1**
3.	Demonstration of Zero energy cool chamber	**1**
4.	Effect of temperature on shelf life and quality of produce (drying and dehydration)	**1**
5.	Demonstration of chilling and freezing injury in vegetables and fruits	**1**
6.	Extraction and preservation of pulps and juices	**1**
7.	Preparation of Jam and Jelly	**1**
8.	Pickles	**1**
9.	RTS, nectar and squash	**1**
10.	Osmotically dried products	**1**
11.	Fruit bar and Candy	**1**
12.	Tomato products (sauce and ketchup)	**1**
13.	Canned products	**1**
14.	Quality evaluation of products - physico-chemical (Moisture, TSS, acidity and ascorbic acid) and sensory	**2**
15.	Visit to processing unit/ industry.	**1**

Reference Books (Post-harvest Management and Value Addition of Fruits and Vegetables) :

S. no.	Title of Book	Author	Publisher
1	Post Harvest Technology of Flowers and Ornamentals Plants (2005)	Battacharjee, S. K. and De, L. C	Pointer Publisher
2	A Handbook on Post Harvest management of Fruits and vegetables (2008)	Jacob John, P	Daya Publishing House, Delhi
3	Food Preservation & Processing (1996)	Manoranjan, K and Sangita, S.	Kalyani Publishers
4	Post Harvest Physiology and Storage of Tropical and Sub-tropical Fruits (1997)	Mitra, S. K.	CAB International
5	Principles of Fruit Preservation (2006)	Morris, T. N.	Biotech Books, Delhi

6	Post harvest Management of Horticultural Crops (2008)	Saraswathy, S. et. al.	Agribios
7	Fruits and vegetable Preservation – Principles and Practice (2002)	Srivastava, R. P. & Sanjeev Kumar	International Book Distributing Co., Lucknow
8	Post Harvest Technology of Fruits and Vegetables Vol. I & II. (2000)	Verma, L. R. and Joshi, V. K.	Indus Publishing Co., New Delhi
9	Text Book of Food Sciences and Technology (2001)	Vijay, K.	ICAR
10	Post Harvest management of Horticultural crops	Mayani, Desai, Vagadia	Jaya Publishing House
11	Good management Practices for Horticultural Crops	Ed. M.K. Jatav, etal.	NIPA
12	Post Harvest management & Processing of fruits & vegetables-Instant notes	Sharma, Satish	NIPA
13	Post Harvest of Horticultural Crops- Practical manual Series Vol.2	Sharma, Satish	NIPA
14	Fruit and Vegetable Phytochemicals: Chemistry, Nutritional Value and Stability	Rosa L.A.	BioGreen
15	Handling, transportation and Storage of Fruits & Vegetables Vol.1 2nd Ed (Vegetables & Melons)	Ryall, A.	Sci Int
16	Handling, transportation and Storage of Fruits & Vegetables Vol.2, 2nd Ed (Fruits & tree nuts)	Ryall, A.	Sci Int
17	Laboratory Manual of Analytical Techniques in Horticulture	Saini, R.	Agro Bot
18	Nutritional Value and Health benefits from fruits, vegetable, nuts & spices	Chavan, U.	Daya
19	Olive: Improvement, Production and Processing	Lal, S.	Astral
20	Ornamental Plants and Garden Design in Tropics and subtropics, Vol-2 sets	Bose, T.	Daya
21	Post Harvest Technology of fruits and Vegetables	Sasikaumar, R.	Biotech

HORT-322	Principles of Food Science & Nutrition	2(2+0)

Theory

Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.); Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions); Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods); Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.); Food and nutrition, Malnutrition (over and under nutrition), nutritional disorders; Energy metabolism (carbohydrate, fat, proteins); Balanced/ modified diets, Menu planning, New trends in food science and nutrition.

S.N.	Name of Topic	Cr Hrs
1	Concepts of Food Science (definitions, measurements, density, phase change, pH, osmosis, surface tension, colloidal systems etc.);	**4**
2	Food composition and chemistry (water, carbohydrates, proteins, fats, vitamins, minerals, flavours, colours, miscellaneous bioactives, important reactions);	**5**
3	Food microbiology (bacteria, yeast, moulds, spoilage of fresh & processed foods, Production of fermented foods);	**5**
4	Principles and methods of food processing and preservation (use of heat, low temperature, chemicals, radiation, drying etc.);	**5**
5	Food and nutrition,	**2**
6	Malnutrition (over and under nutrition),	**2**
7	Nutritional disorders;	**3**
8	Energy metabolism (carbohydrate, fat, proteins);	**2**
9	Balanced/ modified diets,	**1**
10	Menu planning,	**1**
11	New trends in food science and nutrition.	**2**

Livestock Production Management (Name to be rechristened as Animal Production) -

Livestock Production Management Annexures-VIII (1)

LIVESTOCK PRODUCTION MANAGEMENT

ANISC-211	**Livestock and poultry Management**	**4(3+1)**

Theory

Role of livestock in the national economy. Reproduction in farm animals and poultry. Housing principles, space requirements for different species of livestock and poultry. Management of calves, growing heifers and milch animals. Management of sheep, goat and swine. Incubation, hatching and brooding. Management of growers and layers.

Important Indian and exotic breeds of cattle, buffalo, sheep, goat and poultry. Improvement of farm animals and poultry.

Digestion in livestock and poultry. Classification of feedstuffs. Proximate principles of feed. Nutrients and their functions. Feed ingredients for ration for livestock and poultry. Feed supplements and feed additives. Feeding of livestock and poultry.

Introduction of livestock and poultry diseases. Prevention (including vaccination schedule) and control of important diseases of livestock and poultry.

Practical

External body parts of cattle, buffalo, sheep, swine and poultry. Handling and restraining of livestock. Identification methods of farm animals and poultry. Visit to IDF and IPF to study breeds of livestock and poultry and daily routine farm operations and farm records. Judging of cattle, buffalo and poultry. Culling of livestock and poultry. Planning and layout of housing for different types of livestock. Computation of rations for livestock. Formulation of concentrate mixtures. Clean milk production, milking methods. Hatchery operations, incubation and hatching equipments. Management of chicks, growers and layers. Debeaking, dusting and vaccination. Economics of cattle, buffalo, sheep, goat, swine and poultry production.

Lecture schedule of Theory

S.N.	Topic	No. Of Lectures
1	Role of livestock in the national economy.	2
2	Reproduction in farm animals and poultry.	2
3	Housing principles, space requirements for different species of livestock.	3
4	Housing principles, space requirements for different species of poultry.	2
5	Management of calves and growing heifers.	2

6	Management of milch animals.	1
7	Management of sheep.	2
8	Management of goat.	2
9	Management of swine.	1
10	Incubation, hatching and brooding.	3
11	Management of growers and layers.	1
12	Important Indian and exotic breeds of cattle.	2
13	Important Indian and exotic breeds of buffalo	2
14	Important Indian and exotic breeds of sheep.	2
15	Important Indian and exotic breeds of goat.	2
16	Important Indian and exotic breeds of poultry.	2
17	Improvement of farm animals and poultry.	2
18	Improvement of poultry	1
19	Digestion in livestock and poultry.	2
20	Classification of feedstuffs.	1
21	Proximate principles of feed.	1
22	Nutrients and their functions.	2
23	Feed ingredients for ration for livestock and poultry.	2
24	Feed supplements and feed additives.	1
25	Feeding of livestock.	3
26	Feeding of poultry.	2

Practical

1	External body parts of cattle & buffalo sheep	1
2	External body parts of swine & poultry	1
3	Handling and restraining of livestock.	1
4	Identification methods of farm animals& poultry.	1
5	Visit to IDF and IPF to study breeds of livestock and poultry	1
6	Daily routine farm operations and farm records.	1
7	Judging of cattle , buffalo &poultry.	1
8	Culling of livestock and poultry.	1

9	Planning and layout of housing for different types of livestock.	1
10	Computation of rations for livestock.	1
11	Formulation of concentrate mixtures.	1
12	Clean milk production, milking methods.	1
13	Management of chicks, growers and layers.	1
14	Debeaking, dusting and vaccination.	1
15	Economics of cattle, buffalo, sheep, goat, swine and poultry production.	**2**

Suggested Readings:-

Banerjee, G.C. 2013. A Taxe Book of Animal Husbandry. 8th Ed.ICAR.

Choudhary J.L. and Gupta Lokesh. 2016. a Text Book of Animal Husbandry. Somani Publication

Devendra C and Mecleroy GB 1982. Goat and Sheep Production in Tropics.

Dimri,U, Sharma,M C and Tiwari R.2013. Swine Production and Health Management. New India Pub Agency.

Sastry N S R and Thomas, Ck 2006. Livestock Production and Management. Kalyani

Singh, R A. 1996. Poultry Production 3rd Ed Kalyani.

Thomas CK and Sastry,NSR.1991. Dairy Bovine Production. Kalyani.

Genetics & Plant Breeding - Annexures-IX (1) to IX (6)

1	GPB-121	Fundamentals of Genetics	3(2+1)
2	GPB-211	Fundamentals of Plant Breeding	3(2+1)
3.	GPB-221	Principles of Seed Technology	3(1+2)
4.	GPB-311	Crop Improvement-I (*Kharif* crops)	2(1+1)
5.	**GPB-312**	**Intellectual Property Rights**	**1(1+0)**
6.	GPB-322	Micro-propagation Technology (Elective Course)	3(2+1)

PLANT BREEDING & GENETICS

GPB-121	**Fundamentals of Genetics**	**3(2+1)**

Theory

Pre and Post Mendelian concepts of heredity, Mendelian principles of heredity, Cell division – mitosis, meiosis, Probability and Chi-square. Dominance relationships, gene interaction. Multiple alleles, pleiotropism and pseudoalleles. Sex determination and sex linkage,

sex limited and sex influenced traits, Blood group genetics, Linkage and its estimation, crossing over mechanisms, chromosome mapping.

Structural changes in chromosome, Numerical changes in chromosome, Proof for DNA as genetic material and Genetic code, Mutation, classification, Methods of inducing mutation & CIB technique, mutagenic agents and induction of mutation. Qualitative & Quantitative traits, Polygenes and continuous variations, multiple factor hypothesis, Epistatic interactions with examples. Cytoplasmic inheritance. Genetic disorders.

Nature, structure & replication of genetic material. Protein synthesis, Transcription and translational mechanism of genetic material, Gene concept: Gene structure, function and regulation, Lac and Trp operons.

Practical

Study of microscope. Study of cell structure. stains and fixatives, Experiments on monohybrid, dihybrid, trihybrid, test cross and back cross, Experiments on epistatic interactions including test cross and back cross. Practice on mitotic and meiotic cell division, Experiments on probability and Chi-square test. Determination of linkage and cross over analysis (through two point test cross and three point test cross data). Study on sex linked inheritance in Drosophila. Study of models on DNA and RNA structure.

Lecture Schedule

Theory

L. No.	Name of topic	Cr. Hrs.
1	Pre and Post Mendelian concepts of heredity	1
2	Mendelian principles of heredity	1
3	Cell division – mitosis	1
4	Cell division – meiosis	1
5	Probability and Chi-square	1
6	Dominance relationships and gene interaction	1
7	Epistatic gene interactions with examples (complementary, supplementary, duplicate gene interactions)	1
8	Epistatic gene interactions with examples (masking, inhibitory, polymeric and additive gene interactions)	1
9	Pleiotropism, pseudoalleles, Multiple alleles and Blood group genetics	1
10	Sex determination	1
11	Sex limited, sex influenced and sex linked traits	1
12	Sex linkage	1
13	Linkage and its estimation	1
14	Crossing over : introduction & mechanisms	1
15	Chromosome mapping	1

16	Structural changes in chromosome	1
17	Numerical changes in chromosome	1
18	Mutation: introduction, characteristics & classification	1
19	Mutagenic agents: physical and chemical mutagens	1
20	Induction of mutation, Methods of inducing mutation & CIB technique	1
21	Qualitative & Quantitative traits, Polygenes and continuous variations	1
22	Multiple factor hypothesis	1
23	Cytoplasmic inheritance	1
24	Genetic disorders	1
25	Nature, structure and types of genetic material	1
26	Proof for DNA as genetic material	1
27	Replication of genetic material	1
28	Genetic code & Protein synthesis	1
29	Transcription mechanism of genetic material	1
30	Translational mechanism of genetic material	1
31	Gene concept: Gene structure and function	1
32	Gene regulation, operon concept, Lac and Trp operons	1

Practical

L. No.	**Name of topic**	**Cr. Hrs.**
1	Study of microscope: parts and types	1
2	Study of cell structure	1
3	Experiments on monohybrid, test cross and back cross	1
4	Experiments on dihybrid, test cross and back cross	1
5	Experiments on trihybrid, test cross and back cross	1
6	Experiments on epistatic interactions including test cross and back cross	1
7	Experiments on epistatic interactions including test cross and back cross	1
8	Stains and their preparation	1
9	Fixatives and their preparation	1
10	Practice on mitotic cell division	1
11	Practice on meiotic cell division	1

12	Experiments on probability	1
13	Experiments on Chi-square test	1
14	Determination of linkage and cross over analysis (through two point test cross and three point test cross data)	1
15	Study on sex linked inheritance in Drosophila	1
16	Study of models on DNA and RNA structure	1

Reference books:

1. Gupta P.K.2004. Cytology, Genetics and evolution. Rastogi Publications, Meerut. (Hindi Edition)
2. Klug, W.W.and Cummings, M.R.2005.Concepts of genetics Pearson Education (Singapore) pvt. Ltd., Indian Branch, Pratap Ganj, New Delhi.
3. Singh, B.D. 2001.Kalyani Publishing House, New Delhi.
4. Strickberger, M.W.2001.Genetics. Prentice Hall of india. Pvt. Ltd., New Delhi.

GPB-211	**Fundamentals of Plant Breeding**	**3(2+1)**

Theory

Historical development, concept, nature and role of plant breeding, objectives of plant breeding, major achievements and future prospects; Genetics in relation to plant breeding, modes of reproduction and pollination, apomixes, self – incompatibility and male sterility-genetic consequences, cultivar options. Domestication, Acclimatization, introduction; Centre of origin/diversity. Component of Genetic variation; Heritability and genetic advance; Genetic basis and breeding methods in self- pollinated crops- mass and pure line selection, hybridization techniques and handling of segregating population; Multiline concept.

Concepts of population genetics and Hardy-Weinberg Law, Genetic basis and methods of breeding cross pollinated crops, modes of selection; Heterosis and inbreeding depression, development of inbred lines and hybrids, composite and synthetic varieties; population improvement, Breeding methods in asexually propagated crops, clonal selection and hybridization; Wide hybridization and pre-breeding; Polyploidy in relation to plant breeding, mutation breeding-methods and uses;

Breeding for important biotic and abiotic stresses; Biotechnological tools-DNA markers and marker assisted selection. Participatory plant breeding; Intellectual Property Rights, Patenting, Plant Breeders and & Farmer's Rights.

Practical

Plant Breeder's kit, Study of germplasm of various crops. Study of floral structure of self pollinated and cross pollinated crops. Emasculation and hybridization techniques in self & cross pollinated crops.

Consequences of inbreeding on genetic structure of resulting populations. Study of male sterility system. Handling of segregating populations. Methods of calculating mean, range, variance, standard deviation, heritability.

Designs used in plant breeding experiment, analysis of Randomized Block Design and components of genetic variance. To work out the mode of pollination in a given crop and extent of natural out crossing. Prediction of performance of double cross hybrids.

Lecture Schedule

Theory

L. No.	Name of topic	Cr. Hrs.
1	Plant breeding: concept, nature, objectives and role of plant breeding	1
2	Historical development of plant breeding	1
3	Major achievements and future prospects	1
4	Genetics in relation to plant breeding	1
5	Modes of reproduction and pollination, apomixes	1
6	Self – incompatibility	1
7	Male sterility- genetic consequences	1
8	Domestication, Acclimatization, introduction, Centre of origin/diversity	1
9	Component of Genetic variation; Heritability and genetic advance	1
10	Genetic basis of self- pollinated crops and pure line theory	1
11	Breeding methods in self- pollinated crops- mass and pure line selection	1
12	Hybridization techniques	1
13	Handling of segregating population (pedigree, bulk and back cross method)	1
14	Multiline concept	1
15	Concepts of population genetics and Hardy-Weinberg Law	1
16	Genetic basis and methods of breeding cross pollinated crops	1
17	Population improvement and modes of selection	1
18	Heterosis and inbreeding depression	1
19	Development of inbred lines and hybrids	1
20	Composite and synthetic varieties	1
21	Breeding methods in asexually propagated crops	1
22	Clonal selection and hybridization	1

23	Wide hybridization and pre-breeding	1
24	Polyploidy in relation to plant breeding	1
25	Mutation breeding- methods and uses	1
26	Breeding for important biotic and abiotic stresses	1
27	Breeding for important abiotic stresses	1
28	Biotechnological tools-DNA markers,	1
29	Marker assisted selection	1
30	Participatory plant breeding	1
31	Intellectual Property Rights and Patenting	1
32	Plant Breeders and & Farmer's Rights	1

Practical

L. No.	Name of topic	Cr. Hrs.
1	Plant Breeder's kit	1
2	Study of germplasm of various crops	1
3	Study of floral structure of self pollinated crops	1
4	Study of floral structure of cross pollinated crops	1
5	Emasculation and hybridization techniques in self pollinated crops I	1
6	Emasculation and hybridization techniques in self pollinated crops II	1
7	Emasculation and hybridization techniques in self & cross pollinated crops.	1
8	Emasculation and hybridization techniques in self & cross pollinated crops.	1
9	Consequences of inbreeding on genetic structure of resulting populations	1
10	Study of male sterility system	1
11	Handling of segregating populations	1
12	Methods of calculating mean, range, variance, standard deviation, heritability.	1
13	Designs used in plant breeding experiment	1
14	Analysis of Randomized Block Design and components of genetic variance	1
15	To work out the mode of pollination in a given crop and extent of natural out crossing	1
16	Prediction of performance of double cross hybrids	1

Reference books:

1. Alard, R.W. 2000.Principles of Plant Breeding. John Willey & Sons, New York.
2. Chahel, G.S. and S.S. Ghosal.2002.Principles and Procedures of Plant Breeding, Biotechnological and Conventional Approaches. Narosa Publishing House, New Delhi.
3. Singh, B.D. 2005. Plant Breeding. Kalyani Publishing House, New Delhi.
4. Singh, P. 2001.Essentials of Plant Breeding-Principles and Methods. Kalyani Publishing House, New Delhi.
5. Jain,H.K. and M.c. Kharsckwal.2004 Plant Breeding- Mendelian to Molecular approach. Narosa Publishing House, New Delhi.

GPB-221	**Principles of Seed Technology**	**3(1+2)**

Theory

Seed and seed technology: introduction, definition and importance. Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production, seed quality; Definition, Characters of good quality seed, different classes of seed.

Foundation and certified seed production of important cereals (Wheat, Rice, Maize, Sorghum and Bajra), pulses (Urd, Mung, Cowpea, Pigeonpea, Lentil, Gram, Field pea), oilseeds (Soybean, Rapeseed and Mustard, Groundnut, sesame), fodder (Berseem) and vegetables (Potato, cauliflower, tomato and chilli), Seed spices (Cumin, Coriander, Fennel and Fenugreek).

Seed certification, phases of certification, procedure for seed certification, field inspection. Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983.

Varietal Identification through Grow Out Test and Electrophoresis, **Molecular and Biochemical test. Detection of genetically modified crops, Transgene contamination in non-GM crops, GM crops and organic seed production.**

Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing. Seed storage; general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage.

Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing.

Practical

Seed production in major cereals: Wheat, Rice, Maize, Sorghum and Bajra. Seed production in major pulses: Urd, Mung, Cowpea, Pigeonpea, Lentil, Gram, Fieldpea. Seed production in major oilseeds: Soybean, Rapeseed and Mustard, Groundnut. Seed production in vegetable crops & Seed spices.

Seed sampling and testing: Physical purity, germination, viability, etc. Seed and seedling vigour test. Genetic purity test: Grow out test and electrophoresis. Seed certification: Procedure,

Field inspection, Preparation of field inspection report. Visit to seed production farms, seed testing laboratories and seed processing plant.

Lecture Schedule

Theory

L. No.	Name of topic	Cr. Hrs.
1	Seed and seed technology: introduction, definition and importance.	1
2	Deterioration causes of crop varieties and their control; Maintenance of genetic purity during seed production	1
3	Seed quality; Definition, Characters of good quality seed, different classes of seed.	1
4	Foundation and certified seed production of important cereals & fodder	1
5	Foundation and certified seed production of important pulses	1
6	Foundation and certified seed production of important oilseeds	1
7	Foundation and certified seed production of important vegetables	1
8	Foundation and certified seed production of important seed spices	1
9	Seed certification, phases of certification, procedure for seed certification, field inspection.	1
10	Seed Act and Seed Act enforcement. Duty and powers of seed inspector, offences and penalties. Seeds Control Order 1983.	1
11	Varietal Identification through Grow Out Test and Electrophoresis, Molecular and Biochemical test.	1
12	Detection of genetically modified crops, Transgene contamination in non-GM crops	1
13	GM crops and organic seed production.	1
14	Seed drying, processing and their steps, seed testing for quality assessment, seed treatment, its importance, method of application and seed packing.	1
15	Seed storage; general principles, stages and factors affecting seed longevity during storage. Measures for pest and disease control during storage.	1
16	Seed marketing: structure and organization, sales generation activities, promotional media. Factors affecting seed marketing, Role of WTO and OECD in seed marketing.	1

Practical

L. No.	Name of topic	Cr. Hrs.
1	Seed production in wheat including seed standards	1

2	Seed production in rice including seed standards	1
3	Seed production in Maize including seed standards	1
4	Seed production in Sorghum including seed standards	1
5	Seed production in Bajra including seed standards	1
6	Seed production in Urd, mung and cowpea including seed standards	1
7	Seed production in Pigeonpea including seed standards	1
8	Seed production in Lentil including seed standards	1
9	Seed production in Gram including seed standards	1
10	Seed production in Field pea including seed standards	1
11	Seed production in Soybean including seed standards	1
12	Seed production in Rapeseed and Mustard including seed standards	1
13	Seed production in Groundnut and sesame including seed standards	1
14	Seed production in vegetable (Potato, cauliflower, tomato and chilli) crops including seed standards	1
15	Seed production in Seed spices (fenugreek, fennel, cumin & coriander) including seed standards	1
16	Seed sampling methods	1
17	Physical purity test	1
18	Germination test	
19	Viability test	1
20	Seed and seedling vigour test	1
21	Genetic purity test: Grow out test	1
22	Electrophoresis	1
23	Seed certification: Procedure	1
24	Field inspection and Preparation of field inspection report	2
25	Visit to seed production farms	3
26	Visit to seed testing laboratories	2
27	Visit to seed processing plant	2

Reference books:

1. Agarwal, R.L.1991.Seed Technology, Oxford & IBH Publishing Co. Delhi
2. Agarwal, P.K. 1999. Seed Technology, ICAR, New Delhi.
3. Subir Sen and Nabinanda Ghosh.1999. Seed Science and Technology, Kalyani Publishers. New Delhi.

4. Dhirenra Khare and Mohan S. Bhale.2000. Seed Technology. Scientific Publishers (India), Jodhpur.
5. Maloo,S.R., Intodia, S.K. and Pratap Singh.2008. Beej Pradyogiki.Agrotech Publishing Academy.
6. A.K. Joshi and B.D. Singh.2005.Seed Technology. Kalyani Publishers, New Delhi.
7. Arya, P.S. 2001. Vegetable Breeding and Seed Production. Kalyani Pub., Ludhiana
8. Saxena,R.P.1984. Beez Sansadhan, GBPA&T, Pantnagar.
9. Singh, B.D. 2005. Plant Breeding. Kalyani Publishing House, New Delhi.

GPB-311	**Crop Improvement-I (*Kharif* crops)**	**2(1+1)**

Theory

Centers of origin, distribution of species, wild relatives in different cereals (Rice, Maize, Sorghum and Bajra); pulses (Urd, Mung, Cowpea and Pigeonpea); oilseeds (Soybean, sessame and Groundnut); fibres (Cotton); fodders (Bajra) and cash crops (Castor); vegetable and horticultural crops (Chilli and tomato); Plant genetic resources, its utilization and conservation Floral biology, study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops. Hybrid seed production technology in Maize, Rice, Sorghum, Pearl millet and Pigeonpea, etc. Ideotype concept and climate resilient crop varieties for future.

Practical

Emasculation and hybridization techniques in different crop species; viz., Rice, Maize, Sorghum, Pearl Millet, Ragi, Pigeonpea, Urdbean, Mungbean, Soybean, Groundnut, Seasame , Castor, Cotton, Cowpea, Pearl millet and Tobacco. Maintenance breeding of different kharif crops. Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Kharif* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

Lecture Schedule

Theory

L. No.	**Name of topic**	**Cr. Hrs.**
1	Crop improvement aspects in **Rice** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc & hybrid seed production.	1

2	Crop improvement aspects in **Maize** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc & hybrid seed production.	1
3	Crop improvement aspects in **Sorghum** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc& hybrid seed production.	1
4	Crop improvement aspects in **Bajra** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc& hybrid seed production.	1
5	Crop improvement aspects in **Urd, Mung and Cowpea** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
6	Crop improvement aspects in **Pigeonpea** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc& hybrid seed production.	1
7	Crop improvement aspects in **Soybean** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
8	Crop improvement aspects in S**essame** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
9	Crop improvement aspects in **Groundnut** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
10	Crop improvement aspects in **Cotton** and **castor** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
11	Crop improvement aspects in **Chilli** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
12	Crop improvement aspects in **tomato**as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
13	Modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional	1

14	Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops	1

15	Ideotype concept	1
16	Climate resilient crop varieties for future.	1

Practical

L. No.	Name of topic	Cr. Hrs.
1	Emasculation and hybridization techniques in Rice, Maize	1
2	Emasculation and hybridization techniques in Sorghum and Bajra	1
3	Emasculation and hybridization techniques in Urd, Mung, Cowpea, Pigeonpea	1
4	Emasculation and hybridization techniques in, Soybean, sessame	1
5	Emasculation and hybridization techniques in and Groundnut ans cotton	1
6	Maintenance breeding of different kharif crops.	1
7	Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods.	1
8	Study of field techniques for seed production and hybrid seeds production in *Kharif* crops	1
9	Estimation of heterosis, inbreeding depression and heritability	1
10	Layout of field experiments	1
11	Study of quality characters	1
12	Donor parents for different characters	1
13	Visit to seed production plots	2
14	Visit to AICRP plots of different field crops.	2

Reference books:

1. Chopra, V.L. 2000 Breeding of Field Crops (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chaddha. K.L. and Rajendra Gupta. 1995. Advances in Horticulture Vol. II Medicinal and Aromatic Plant. Malhotra Publishing House, New Delhi.
3. Mandal, AK., P.K. Ganguli and S.P. Banerjee. 1991. Advances in Plant Breeding Vol. I and II. CBS Publishers and Distributors, New Delhi.
4. Manjit S. Kang 2004. Crop Improvement: Challenges in the Twenti-First Century (Edt). International Book Distributing Co. Lucknow.
5. Poehlman, J.M. 1987. Breeding of Field Crops. AVI Publishing Co.. INC, East Port, Conneacticut, USA.
6. Ram, H.H. and H.G. Singh. 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.

7. Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.
8. Ram. H.H. 2005. Vegetable Breeding – Principles and Practices. Kalyani Publishers, New Delhi.

GPB-312	**Intellectual Property Rights**	**1(1+0)**

Theory

Introduction and meaning of intellectual property, brief introduction to GATT, WTO, TRIPs and WIPO, Treaties for IPR protection: Madrid protocol, Berne Convention, Budapest treaty, etc.

Types of Intellectual Property and legislations covering IPR in India:-Patents, Copyrights,

Trademark, Industrial design, Geographical indications, Integrated circuits, Trade secrets. Patents Act 1970 and Patent system in India, patentability, process and product patent, filing of patent, patent specification, patent claims, Patent opposition and revocation, infringement, Compulsory licensing, Patent Cooperation Treaty, Patent search and patent database.

Origin and history including a brief introduction to UPOV for protection of plant varieties, Protection of plant varieties under UPOV and PPV&FR Act of India, Plant breeders rights, Registration of plant varieties under PPV&FR Act 2001, breeders, researcher and farmers rights. Traditional knowledge-meaning and rights of TK holders.

Convention on Biological Diversity, International treaty on plant genetic resources for food and agriculture (ITPGRFA). Indian Biological Diversity Act, 2002 and its salient features, access and benefit sharing.

GPB-321	**Crop Improvement-II *(Rabi crops)***	**2 (1+1)**

Theo**ry**

Centers of origin, distribution of species, wild relatives in different cereals(Wheat, Oat and Barley); pulses(Chickpea, Lentil and Field pea); oilseeds (Rapeseed Mustard and Sunflower); fodder crops (Berseem) and cash crops (Sugarcane); vegetable and horticultural crops (Potato); Plant genetic resources, its utilization and conservation; Floral biology, study of genetics of qualitative and quantitative characters; Important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops; Major breeding objectives and procedures including conventional and modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional); Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops. Hybrid seed production technology of rabi crops. Ideotype concept and climate resilient crop varieties for future.

Practical

Emasculation and hybridization techniques in different crop species namely Wheat, Oat, Barley, Chickpea, Lentil, Field pea, Rapeseed Mustard, Sunflower, Potato, Berseem. Sugarcane, Cowpea; Handling of germplasm and segregating populations by different methods like pedigree, bulk

and single seed decent methods; Study of field techniques for seed production and hybrid seeds production in *Rabi* crops; Estimation of heterosis, inbreeding depression and heritability; Layout of field experiments; Study of quality characters, study of donor parents for different characters; Visit to seed production plots; Visit to AICRP plots of different field crops.

Suggestions & modifications:

Lecture Schedule

Theory

L. No.	Name of topic	Cr. Hrs.
1	Crop improvement aspects in **Wheat** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
2	Crop improvement aspects in **Oat** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
3	Crop improvement aspects in **Barley** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
4	Crop improvement aspects in **Chickpea** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
5	Crop improvement aspects in **Lentil** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
6	Crop improvement aspects in **Pigeonpea** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc & hybrid seed production.	1
7	Crop improvement aspects in **Field pea** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
8	Crop improvement aspects in **Rapeseed Mustard** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc. (2 lectures)	1
9	Crop improvement aspects in **Rapeseed Mustard** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc & hybrid seed production	1
10	Crop improvement aspects in **Sunflower** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
11	Crop improvement aspects in **Berseem** and **potato** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology	1

	breeding objectives and procedures etc & hybrid seed production.	
12	Crop improvement aspects in **Sugarcane** as mentioned in the syllabus such as Centers of origin, distribution of species Floral biology breeding objectives and procedures etc.	1
13	Modern innovative approaches for development of hybrids and varieties for yield, adaptability, stability, abiotic and biotic stress tolerance and quality (physical, chemical, nutritional	1
14	Seed production technology in self pollinated, cross pollinated and vegetatively propagated crops	1
15	Ideotype concept	1
16	Climate resilient crop varieties for future.	1

Practical

L. No.	Name of topic	Cr. Hrs.
1	Emasculation and hybridization techniques in Wheat, Oat, Barley	1
2	Emasculation and hybridization techniques in Chickpea, Lentil, Field pea	1
3	Emasculation and hybridization techniques in Rapeseed Mustard	1
4	Emasculation and hybridization techniques in Sunflower, Potato	1
5	Emasculation and hybridization techniques in Berseem. Sugarcane	1
6	Maintenance breeding of different rabi crops.	1
7	Handling of germplasm and segregating populations by different methods like pedigree, bulk and single seed decent methods.	1
8	Study of field techniques for seed production and hybrid seeds production in *rabi* crops	1
9	Estimation of heterosis, inbreeding depression and heritability	1
10	Layout of field experiments	1
11	Study of quality characters	1
12	Donor parents for different characters	1
13	Visit to seed production plots	2
14	Visit to AICRP plots of different field crops.	2

Reference books:

1. Chopra, V.L. 2000 Breeding of Field Crops (Edt.). Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Chaddha. K.L. and Rajendra Gupta. 1995. Advances in Horticulture Vol. II Medicinal and Aromatic Plant. Malhotra Publishing House, New Delhi.
3. Mandal, AK., P.K. Ganguli and S.P. Banerjee. 1991. Advances in Plant Breeding Vol. I and II. CBS Publishers and Distributors, New Delhi.

4. Manjit S. Kang 2004. Crop Improvement: Challenges in the Twenti-First Century (Edt). International Book Distributing Co. Lucknow.
5. Poehlman, J.M. 1987. Breeding of Field Crops. AVI Publishing Co.. INC, East Port, Conneacticut, USA.
6. Ram, H.H. and H.G. Singh. 1994. Crop Breeding and Genetics. Kalyani Publishers, New Delhi.
7. Sharma, A.K. 2005. Breeding Technology of Crop Plants (Edt.). Yash Publishing House, Bikaner.
8. Ram. H.H. 2005. Vegetable Breeding – Principles and Practices. Kalyani Publishers, New Delhi.

GPB-322	**Micro-propagation Technology (Elective Course)**	**3(2+1)**

Theory

Meaning and concept of *in vitro* culture and micro-propagation; Historical milestones, advancement and future prospects of micro-propagation; totipotency, dedifferentiation; Tissue culture methodology: Sterile techniques, synthetic and natural media components, growth regulators, environmental requirement, genetic control of regeneration; Plant regeneration pathways - Organogenesis and Somatic embryogenesis;

Micro-propagation- Definition, methods, stages of micro-propagation and its significance; Axillary bud proliferation approach- Shoot tip and meristem culture; Organogenesis- Purpose, methods and requirements for organogenesis, indirect and direct organogenesis; Somatic embryogenesis- Procedures and requirements for organogenesis, indirect and direct embryogenesis; Differences between somatic and gametic embryogenesis, Synthetic seed- Concepts, necessity, procedure and requirements for production of synthetic seeds.

Practical

Laboratory organization, sterilization techniques for explants, glassware, plastic wares, lab wares and working platform. Preparation of stocks and working solution. Preparation and sterilization of growth regulators.

Preparation of working medium and experimentation on determining optimum concentration of growth regulators. Callus induction and regeneration of whole plants from different parts of plants. Direct regeneration into whole plants using bud, node and other tissues.

Induction of somatic embryos. Experiments of synthetic seeds production and testing storability and germination efficiency.

Lecture Schedule

Theory

L. No.	Name of topic	Cr. Hrs.
1	Meaning and concept of *in vitro* culture and micro-propagation	1
2	Historical milestones of *in vitro* culture and micro-propagation	1
3	Advancement and future prospects of micro-propagation	1

4	Totipotency, dedifferentiation	1
5	Tissue culture methodology: Sterilization techniques	1
6	Synthetic and natural media components	1
7	Growth regulators used in tissue culture media	1
8	Environmental requirement	1
9	Genetic control of regeneration	1
10	Plant regeneration pathways- Organogenesis and Somatic embryogenesis;	1
11	Micro-propagation- Definition, methods, stages of micro-propagation and its significance	1
12	Axillary bud proliferation approach- Shoot tip and meristem culture	1
13	Organogenesis- Purpose, methods and requirements for organogenesis, indirect and direct organogenesis	1
14	Somatic embryogenesis- Procedures and requirements for organogenesis, indirect and direct embryogenesis	1
15	Differences between somatic and gametic embryogenesis,	1
16	Synthetic seed-Concepts, necessity, procedure and requirements for production of synthetic seeds.	1

Practical

L. No.	**Name of topic**	**Cr. Hrs.**
1	Laboratory organization	1
2	Sterilization techniques for explants	2
3	Sterilization techniques for glassware	2
4	Sterilization techniques for plastic wares	2
5	Sterilization techniques for lab wares	2
6	Sterilization techniques for working platform	2
7	Preparation of stocks and working solution	1
8	Preparation of stocks and working solution	1
9	Preparation and sterilization of growth regulators.	1
10	Preparation of working medium	2
11	Experimentation on determining optimum concentration of growth regulators.	2
12	Callus induction and regeneration of whole plants from different parts of plants.	4
13	Direct regeneration into whole plants using bud	2

14	Direct regeneration into whole plants node	2
15	Direct regeneration into whole plants other tissues	2
16	Induction of somatic embryos	1
17	Experiments of synthetic seeds production	1
18	Testing storability of synthetic seed	1
19	Germination efficiency of synthetic seed	1

Reference books:

1. Chawala H S (2000) Introduction to Plant Biotechnology. Oxford & IBH
2. Gupta, P. K. (2008) Elements of biotechnology Rastogi publications meerut
3. Ray V. Herren (2005)Introduction to biotechnology (An Agricultural revolution)
4. Shekhawat, MS (2011) Plant Biotechnology, In vitro princioles, Techniques and Applications, MJP Publishers, Chennai
5. Mascarenhas, A. F. (2008) Hand book of Plant tissue Culture, ICAR.
6. Singh BD. 2005. *Biotechnology, Expanding Horizons*. Kalyani.

Plant Pathology- Annexures-X (1) to X (4)

1.	PPATH-121	Fundamentals of Plant Pathology	3(2+1)
2.	PPATH-311	Epidemiology and Integrated Disease Management	2(1+1)
3.	PPATH-312	Diseases of Field and Horticultural Crops and their Management-I	3(2+1)
4.	PPATH-321	Diseases of Field and Horticultural Crops and their Management-II	3(2+1)

Department of Plant Pathology

PPATH-121	**Fundamentals of Plant Pathology**	**3(2+1)**

Theory

Introduction: Importance of plant diseases, scope and objectives of Plant Pathology. History of Plant Pathology with special reference to Indian work. Terms and concepts in Plant Pathology. Pathogenesis. Causes and classification of plant diseases. Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vesicular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them. Diseases and symptoms due to abiotic causes.

Fungi: general characters, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus, reproduction (asexual and sexual). Nomenclature, Binomial system of nomenclature, classification of fungi (key to Domain to Phylum).

Bacteria and mollicutes: general morphological characters, reproduction and classification of plant pathogenic bacteria. **Viruses:** nature, structure and transmission.

Nematodes: General morphology, outline of classification, symptoms and nature of damage caused by plant nematodes (*Heterodera, Meloidogyne* and *Anguina*).

Role of enzymes and toxins in disease development. Defense mechanism in plants.

Practical

Acquaintance with various laboratory equipments and microscopy. Preparation of media, isolation and Koch's postulates. General study of different structures of fungi. Study of symptoms of various plant diseases. Staining and identification of plant pathogenic bacteria. Transmission of plant viruses. Identification of plant parasitic nematodes (*Heterodera, Meloidogyne* and *Anguina*). Sampling and extraction of nematodes from soil and plant material, preparation of nematode mounting.

Lecture Schedule: Theory

S.No.	Topic	No. of lectures
1	Importance of plant diseases, scope and objectives of Plant Pathology	1
2	History of Plant Pathology with special reference to Indian work.	3
3	Terms and concepts in Plant Pathology	3
4	Pathogenesis.	2
5	Causes and classification of plant diseases.	1
6	Important plant pathogenic organisms, different groups: fungi, bacteria, fastidious vascular bacteria, phytoplasmas, spiroplasmas, viruses, viroids, algae, protozoa, phanerogamic parasites and nematodes with examples of diseases caused by them.	3
7	Diseases and symptoms due to abiotic causes.	1
8	**Fungi:** General characters, somatic structures, types of fungal thalli, fungal tissues, modifications of thallus,	2
9	**Fungi:** Reproduction (asexual and sexual).	1
10	**Fungi:** Nomenclature, Binomial system of nomenclature, classification of fungi (key to Domain to Phylum).	3
11	**Bacteria and mollicutes:** General morphological characters, reproduction and classification of plant pathogenic bacteria.	2
12	Classification of plant pathogenic bacteria.	2
13	**Viruses:** nature, structure and transmission.	2

14	**Nematodes:** General morphology, outline of classification,	2
15	**Nematodes:** Symptoms and nature of damage caused by plant nematodes (*Heterodera, Meloidogyne* and *Anguina*).	2
16	Role of enzymes and toxins in disease development.	1
17	Defense mechanism in plants.	1

Lecture Schedule: Practical

S.No.	Topic	No. of lectures
1	Acquaintance with various laboratory equipments and microscopy	2
2	Preparation of media and isolation	2
3	Koch's postulates	1
4	General study of different structures of fungi	1
5	Study of symptoms of various plant diseases	2
6	Staining and identification of plant pathogenic bacteria	2
7	Transmission of plant viruses	2
8	Identification of plant parasitic nematodes (*Heterodera, Meloidogyne* and *Anguina*)	2
9	Sampling and extraction of nematodes from soil and plant material and preparation of nematode mounting	2

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7. Dube, H.C. 2012, Modern Plant Pathology, 2nd ed. Agrobios (India), Jodhpur
8. Dube, H.C. 2013, An Introduction to Fungi. 4th ed. , Scientific Publishers India, Jodhpur.

PPATH-311	Epidemiology and Integrated Disease Management	2(1+1)

THEORY

Epidemiology and factors affecting disease development. Diagnosis of plant diseases. Disease triangle and tetrahedron. Forecasting of plant diseases.

Principles of plant disease management. Methods of integrated disease management: Host plant resistance, cultural, physical, legislative, biological and chemical control. IDM modules for wheat, rice, sugarcane, cotton, groundnut, mustard, potato, cumin, citrus and chickpea. Integrated nematode management in protected cultivation. Nature, chemical combination, general classification of fungicides and antibiotics. Safety issues in fungicidal uses. Pest risk analysis.

PRACTICAL

Diagnosis of plant diseases. Methods of plant disease measurement. Assessment of crop yield losses. Identification of bio-control agents. Mass multiplication of *Trichoderma, Pseudomona*s and *Bacillus*. Methods of pesticide application and their safe use. Study of structural details of sprayers, dusters and seed dressers. Awareness campaign at farmer's fields.

Lecture Schedule: Theory

S.No.	Topic	No. of lectures
1	Epidemiology and factors affecting disease development	1
2	Diagnosis of plant diseases	1
3	Disease triangle and tetrahedron	1
4	Forecasting of plant diseases	1
5	Principles of plant disease management	1
6	Methods of integrated disease management: Host plant resistance, cultural, physical, legislative, biological and chemical control	4
7	IDM modules for wheat, rice, sugarcane, cotton, groundnut, mustard, potato, cumin, citrus and chickpea	2
8	Integrated nematode management in protected cultivation	1
9	Nature, chemical combination, general classification of fungicides and antibiotics	3
10	Safety issues in fungicidal uses. Pest risk analysis	1

Lecture Schedule: Practical

S.No.	Topic	No. of lectures
1	Diagnosis of plant diseases.	2

2	Methods of plant disease measurement.	2
3	Assessment of crop yield losses.	1
4	Identification of bio-control agents.	3
5	Mass multiplication of *Trichoderma, Pseudomona*s and *Bacillus*.	3
6	Methods of pesticide application and their safe use.	2
7	Study of structural details of sprayers, dusters and seed dressers.	2
8	Awareness campaign at farmer's fields.	1

References:

1. Agrios, G.N. 2005. Plant Pathology. 5th ed. Academic Press, New York.
2. Mehrotra, R.S. and Agrawal, A. 2013. Plant Pathology. 2nd ed. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
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PPATH-312	**Diseases of Field and Horticultural Crops and their Management-I**	**3(2+1)**

THEORY

Symptoms, etiology, disease cycle and management of major diseases of following crops:

FIELD CROPS: Rice: Blast, brown spot, bacterial blight, sheath blight, khaira and tungro. **Maize:** Stalk rots, leaf blights and downy mildews. **Sorghum:** Grain smut and anthracnose. **Bajra:** Downy mildew and ergot. **Groundnut:** Tikka, collar rot and peanut clump virus. **Soybean:** Rhizoctonia blight and bacterial pustule. **Pigeon pea**: Sterility mosaic. **Moong, urd and moth beans:** Web blight and yellow mosaic. **Castor:** Phytophthora blight and bacterial blight. **Guar:** Bacterial blight and Alternaria blight. **Sesamum:** Stem & root rot and phyllody. **Cotton:** Wilt, root rot, bacterial blight and leaf curl.

HORTICULTURAL CROPS: Guava: Wilt and zinc deficiency. **Banana:** Panama wilt, Sigatoka and bunchy top. **Papaya:** Foot rot, leaf curl, ring spot and root knot. **Pomegranate:** leaf spots and Bacterial blight. **Cabbage**: Alternaria leaf spot and black rot. **Brinjal:** Phomopsis blight and little leaf. **Tomato:** Damping off, bacterial wilt, early blight, leaf curl and root knot. **Okra:** Yellow vein mosaic. **Ginger:** Rhizome rot. **Date palm**: Graphiola leaf spot. **Coconut:** Root wilt, cadang cadang and bud rot. **Tea:** Blister blight and red rust. **Coffee:** Rust.

PRACTICAL:

Identification and histopathological studies of following selected diseases of field and horticultural crops. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

Maize: Stalk rots, leaf blights and downy mildews. **Sorghum:** Grain smut and anthracnose. **Bajra:** Downy mildew and ergot. **Groundnut:** Tikka, collar rot and peanut clump virus. **Soybean:** Rhizoctonia blight and bacterial pustule. **Pigeon pea**: Sterility mosaic. **Moong, urd and moth beans:** Web blight and yellow mosaic. **Castor:** Bacterial blight. **Guar:** Bacterial blight and Alternaria blight. **Sesamum:** Phyllody. **Cotton:** Wilt, root rot, bacterial blight and leaf curl. **Guava**: Wilt and zinc deficiency. **Banana:** Sigatoka and bunchy top. **Papaya:** Leaf curl, ring spot and root knot. **Pomegranate:** leaf spots and Bacterial blight. **Cabbage**: Alternaria leaf spot and black rot. **Brinjal:** Little leaf. **Tomato:** Damping off, bacterial wilt, early blight, leaf curl and root knot. **Okra:** Yellow vein mosaic. **Ginger:** rhizome rot. **Date palm**: Graphiola leaf spot.

Note: Students should submit 30 pressed and well-mounted specimens.

Lecture Schedule: Theory

S.No.	Topic	No. of lectures
1	**Rice:** Blast, brown spot, bacterial blight, sheath blight, khaira and tungro.	3
2	**Maize:** Stalk rots, leaf blights and downy mildews.	2
3	**Sorghum:** Grain smut and anthracnose.	1
4	**Bajra:** Downy mildew and ergot.	1
5	**Groundnut:** Tikka, collar rot and peanut clump virus.	2
6	**Soybean:** Rhizoctonia blight and bacterial pustule.	1
	Moong, urd and moth beans: Web blight and yellow mosaic. **Pigeon pea**: Sterility mosaic. **Okra:** Yellow vein mosaic.	2
7	**Castor:** Phytophthora blight and bacterial blight.	1
8	**Guar:** Bacterial blight and Alternaria blight.	1
9	**Sesamum:** Stem & root rot and phyllody.	1
10	**Cotton:** Wilt, root rot, bacterial blight and leaf curl.	2
11	**Guava**: Wilt and zinc deficiency.	1
12	**Banana:** Panama wilt, Sigatoka and bunchy top.	2
13	**Papaya:** Foot rot, leaf curl, ring spot and root knot.	2
14	**Pomegranate:** leaf spots and Bacterial blight.	1
15	**Cabbage**: Alternaria leaf spot and black rot.	1
16	**Brinjal:** Phomopsis blight and little leaf.	1
17	**Tomato:** Damping off, bacterial wilt, early blight, leaf curl and root knot.	3

18	**Ginger:** Rhizome rot. **Date palm**: Graphiola leaf spot.	1
19	**Coconut:** Root wilt, cadang cadang and bud rot.	2
20	**Tea:** Blister blight and red rust. **Coffee:** Rust.	1

Lecture Schedule: Practical

S.No.	Topic	No. of lectures
1	Identification and histopathological studies of following selected diseases of field and horticultural crops:	-
2	**Maize:** Stalk rots, leaf blights and downy mildews.	1
3	**Sorghum:** Grain smut and anthracnose.	1
4	**Bajra:** Downy mildew and ergot.	1
5	**Groundnut:** Tikka, collar rot and peanut clump virus.	1
6	**Soybean:** Rhizoctonia blight and bacterial pustule. **Pigeon pea**: Sterility mosaic. **Moong, urd and moth beans:** Web blight and yellow mosaic.	1
7	**Castor:** Bacterial blight. **Guar:** Bacterial blight and Alternaria blight. **Cabbage**: Alternaria leaf spot and black rot.	1
8	**Sesamum:** Phyllody. **Brinjal:** Little leaf.	1
9	**Cotton:** Wilt, root rot, bacterial blight and leaf curl.	1
10	**Guava**: Wilt and zinc deficiency. **Banana:** Sigatoka and bunchy top.	1
12	**Papaya:** Leaf curl, ring spot and root knot.	1
13	**Pomegranate:** leaf spots and Bacterial blight.	1
14	**Tomato:** Damping off, bacterial wilt, early blight, leaf curl and root knot.	1
15	**Okra:** Yellow vein mosaic. **Ginger:** rhizome rot. **Date palm**: Graphiola leaf spot.	1
16	Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.	2
17	**Note:** Students should submit 30 pressed and well-mounted specimens.	-

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Cook, A A. 1981. Diseases of Tropical and Sub-Tropical Field Fiber and Oil Plants. Mac Millan Publishing Co. New York.

Gupta V K and Paul Y S. 2002. Diseases of Field Crops. Indus Publishing Co. New Delhi.

Mehrotra R S and Agrawal A. 2013. Plant Pathology. 2nd.ed. Tata McGraw-Hill Publishing Co Ltd. New Delhi.

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PPATH-321	**Diseases of Field and Horticultural Crops and their Management-II**	**3(2+1)**

THEORY

Symptoms, etiology, disease cycle and management of major diseases of following crops:

FIELD CROPS: Wheat: Rusts, loose smut, karnal bunt, powdery mildew and ear cockle & tundu. **Barley:** Stripe, covered smut and molya disease. **Sugarcane:** Red rot, whip smut, grassy shoot, ratoon stunting and Pokkah boeng. **Sunflower**: Alternaria blight. **Lentil:** Wilt. **Mustard:** Alternaria blight, white rust and Sclerotinia rot. **Gram:** Root rot, wilt and Ascochyta blight. **Isabgol:** Downy mildew. **Coriander:** Stem gall. **Cumin**: Wilt, powdery mildew and Alternaria blight. **Fenugreek:** Powdery mildew.

HORTICULTURAL CROPS: Mango: Malformation and black tip. **Citrus:** Canker, dieback and gummosis. **Grape vine:** Downy mildew and anthracnose. **Apple:** Scab. **Ber:** Powdery mildew. **Aonla:** Rust. **Potato:** Late blight, black heart, golden nematode and leaf roll. **Cucurbits:** Powdery mildew, mosaic, Choanephora rot and root knot. **Onion**: Purple blotch. **Chillies:** Anthracnose and leaf curl. **Pea:** Root rot and powdery mildew. **Carrot:** Alternaria blight. **Rose:** Dieback and powdery mildew. **Marigold:** Blight.

PRACTICAL:

Identification and histopathological studies of following selected diseases of field and horticultural. Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.

Wheat: Rusts, loose smut, karnal bunt and ear cockle. **Barley:** Stripe, covered smut and molya disease. **Sugarcane:** Red rot, whip smut and grassy shoot. **Sunflower**: Alternaria blight. **Lentil:** Wilt. **Mustard:** Alternaria blight, white rust and Sclerotinia stem rot. **Gram:** Root rot, wilt and Ascochyta blight. **Isabgol:** Downy mildew. **Coriander:** Stem gall. **Cumin**: Wilt, powdery mildew and Alternaria blight. **Fenugreek:** Powdery mildew.

Mango: Malformation and black tip. **Citrus:** Canker, dieback and gummosis. **Grape vine:** Downy mildew and anthracnose. **Ber:** Powdery mildew. **Aonla:** Rust. **Potato:** Late blight, black

heart, golden nematode and leaf roll. **Cucurbits:** Powdery mildew, mosaic, Choanephora rot and root knot. **Onion**: Purple blotch. **Chillies:** Anthracnose and leaf curl. **Pea:** Root rot and powdery mildew. **Carrot:** Alternaria blight. **Rose:** Dieback and powdery mildew. **Marigold:** Blight.

Note: Students should submit 30 pressed and well-mounted specimens.

Lecture Schedule: Theory

S.No.	Topic	No. of lectures
1	**Wheat**: Rusts, loose smut, karnal bunt, powdery mildew and ear cockle & tundu.	4
2	**Barley:** Stripe, covered smut and molya disease.	2
3	**Sugarcane:** Red rot, whip smut, grassy shoot, ratoon stunting and Pokkah boeng.	3
4	**Mustard:** Alternaria blight, white rust and Sclerotinia rot. **Sunflower**: Alternaria blight.	2
5	**Gram:** Root rot, wilt and Ascochyta blight. **Lentil:** Wilt.	2
6	**Coriander:** Stem gall. **Fenugreek:** Powdery mildew. **Cumin**: Wilt, powdery mildew and Alternaria blight.	3
	Mango: Malformation and black tip.	2
7	**Citrus:** Canker, dieback and gummosis.	1
8	**Grape vine:** Downy mildew and anthracnose. **Isabgol:** Downy mildew.	1
9	**Apple:** Scab. **Aonla:** Rust.	1
10	**Potato:** Late blight, black heart, golden nematode and leaf roll.	3
11	**Cucurbits:** Powdery mildew, mosaic, Choanephora rot and root knot.	2
12	**Onion**: Purple blotch. **Carrot:** Alternaria blight.	1
13	**Chillies:** Anthracnose and leaf curl.	1
14	**Pea:** Root rot and powdery mildew. **Ber:** Powdery mildew.	2
15	**Rose:** Dieback and powdery mildew.	1
16	**Marigold:** Blight.	1

Lecture Schedule: Practical

S.No.	Topic	No. of lectures
1	Identification and histopathological studies of following selected diseases of field and horticultural crops:	-
2	**Wheat**: Rusts, loose smut, karnal bunt and ear cockle.	1

3	**Barley:** Stripe, covered smut and molya disease.	1
4	**Sugarcane:** Red rot, whip smut and grassy shoot.	1
5	**Mustard:** Alternaria blight, white rust and Sclerotinia stem rot.	1
6	**Gram:** Root rot, wilt and Ascochyta blight. **Lentil:** Wilt.	1
7	**Coriander:** Stem gall. **Cumin**: Wilt, powdery mildew and Alternaria blight. **Fenugreek:** Powdery mildew. **Ber:** Powdery mildew.	1
8	**Mango**: Malformation and black tip. **Aonla:** Rust.	1
9	**Citrus:** Canker, dieback and gummosis.	1
10	**Grape vine:** Downy mildew and anthracnose. **Isabgol:** Downy mildew.	1
12	**Potato:** Late blight, black heart, golden nematode and leaf roll.	1
13	**Cucurbits:** Powdery mildew, mosaic, Choanephora rot and root knot.	1
14	**Chillies:** Anthracnose and leaf curl. **Pea:** Root rot and powdery mildew. **Rose:** Dieback and powdery mildew. **Marigold:** Blight.	1
15	**Sunflower**: Alternaria blight. **Onion**: Purple blotch. **Carrot:** Alternaria blight.	1
16	Field visit for the diagnosis of field problems. Collection and preservation of plant diseased specimens for herbarium.	2
17	**Note:** Students should submit 30 pressed and well-mounted specimens.	-

References

Cook, A A. 1981. Diseases of Tropical and Sub-Tropical Field Fiber and Oil Plants. Mac Millan Publishing Co. New York.

Gupta V K and Paul Y S. 2002. Diseases of Field Crops. Indus Publishing Co. New Delhi.

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Physiology (Name to be rechristened as Crop Physiology) - Annexures-XI (1)

PLANT PHYSIOLOGY

CPHYS-121	**Fundamentals of Crop Physiology**	**2(1+1)**

Theory: Introduction to crop physiology and its importance in Agriculture. Plant cell: an Overview, Diffusion and osmosis, Absorption of water, transpiration and Stomatal Physiology. Mineral nutrition of Plants; functions and deficiency symptoms of nutrients and nutrient uptake mechanisms. Photosynthesis; Light reaction and Dark reactions:C_3, C_4 and CAM plants. Respiration; Glycolysis, TCA cycle and electron transport chain. Physiology of flowering. Plant growth regulators; physiological roles and agricultural uses. Physiological aspects of growth and development of major crops. Growth analysis. Role of Physiological growth parameters in crop productivity.

Practical: Preparation of solutions and buffers. Demonstration of the process of osmosis, plasmolysis, root pressure in plants. Measurement of transpiration rate using Ganongs potometer. Estimation of relative water content in plants. Visual symptoms of nutrient deficiency in plants. To study structure and distribution of stomata in leaf. Separation of photosynthetic pigments through paper chromatography. To demonstrate that O_2 is evolved during photosynthesis and light and CO_2 is essential for photosynthesis using Molls half leaf experiment. Measurement of photosynthetic CO_2 assimilation by Infra Red Gas Analyzer (IRGA. Demonstration of anaerobic respiration. Measurement of respiration quotient, plant growth by Arc auxanometer and growth analysis parameters.

Lecture Schedules

Theory

L. No.	Name of topic	Cr. Hrs.
1	Introduction to crop physiology and its importance in Agriculture	1
2	Plant cell: an Overview	1
3	Diffusion and osmosis, Absorption of water, transpiration and Stomatal Physiology	2
4	Mineral nutrition of Plants: Functions and deficiency symptoms of nutrients and nutrient uptake mechanisms	2
5	Photosynthesis: Light reaction	1
6	Dark reactions:C_3, C_4 and CAM plants	1
7	Respiration; Glycolysis	1
8	TCA cycle and electron transport chain	1
9	Physiology of flowering	1
10	Plant growth regulators: Physiological roles and agricultural uses	2
11	Physiological aspects of growth and development of major crops	1
12	Growth analysis, Role of Physiological growth parameters in crop productivity	2

Practical

L. No.	Name of topic	Cr. Hrs.
1	To prepare solutions and buffers	1
2	To demonstrate the process of osmosis	1
3	To demonstrate the process of plasmolysis	1
4	To measure the root pressure in plants	1
5	To measure the rate of transpiration using Ganongs potometer	1
6	Estimation of relative water content in plants	1
7	Visual symptoms of nutrient deficiency in plants	1
8	To study structure and distribution of stomata in leaf	1
9	Separation of photosynthetic pigments through paper chromatography	1
10	To demonstrate that O_2 is evolved during photosynthesis	1
11	To demonstrate that light and CO_2 is essential for photosynthesis using Molls half leaf experiment	1
12	Measurement of photosynthetic CO_2 assimilation by Infra Red Gas Analyzer (IRGA)	1
13	To demonstrate anaerobic respiration	1
14	Measurement of respiration quotient	1
15	Measurement of plant growth by Arc auxanometer	1
16	Measurement of growth analysis parameters	1

Reference books:

1. S. N. Pandey and B. K. Sinha.1977.Plant Physiology. Vikas Publishing House Pvt. Ltd, New Delhi.
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Soil Science & Agricultural Chemistry- Annexures-XI1 (1) to XII (4)

1	SSAC-111	Fundamentals of Soil Science	3(2+1)
2	SSAC-121	Agricultural Microbiology (Course to be shared with Plant Pathology)	2(1+1)
3	SSAC-221	Problematic soils and their Management	2(1+1)
4.	SSAC-311	Manures, fertilizers and Soil Fertility Management	3(2+1)

SOIL SCIENCE & AGRIL. CHEMISTRY

SSAC-111	**Fundamentals of Soil Science**	**3(2+1)**

Theory

Soil as a natural body, Pedological and edaphological concepts of soil; Soil genesis: soil forming rocks and minerals; weathering, processes and factors of soil formation; Soil Profile, components of soil; Soil physical properties: soil-texture, structure, density and porosity, soil colour, consistence and plasticity; soil taxonomical classification and soils of India; Soil water retention, movement and availability; Soil air, composition, gaseous exchange, problem and plant growth, Soil temperature; source, amount and flow of heat in soil; effect on plant growth, Soil reaction-pH, soil acidity and alkalinity, buffering, effect of pH on nutrient availability; soil colloids - inorganic and organic; silicate clays: constitution and properties; sources of charge; ion exchange, cation exchange capacity, base saturation;.

Practical

Study of soil profile in field. Study of soil sampling tools, collection of representative soil sample, its processing and storage. Study of soil forming rocks and minerals. Determination of soil density, moisture content and porosity. Determination of soil texture by feel and Bouyoucos Methods. Determination of soil pH and electrical conductivity. Determination of cation exchange capacity of soil.Determination of soil colour.

Lecture Schedule – Theory

S. No	Topic	No. of lecture
1.	Soil as a natural body, Pedological and edaphological concepts of soil	1
2.	Soil genesis: soil forming rocks and minerals classification	2
3.	Weathering of rocks - Chemical, Physical and Biological	2
4.	Factors of soil formation, fundamental and specific soil forming processes	2
5.	Soil Profile	1
6.	Definition and components of soil	1
7.	Soil Physical properties- Soil texture, classifications of soil separates, importance of soil texture, particle size analysis. Stoke's law	2
8.	Soil structure and types of soil structure, mechanism of soil structure formation, management of soil structure.	2
9.	Bulk density, particle density and porosity, factors affecting them, agricultural significance and manipulation	1
10.	soil consistence and plasticity and their agricultural significance	1
11.	Soil colour and expression of soil colour with munsell soil colour chart	1

12.	soil taxonomical classification and soils of India	2
13.	Soil water classification, forces of soil water retention	2
14.	Movement of soil water and availability to plants	1
15.	Soil air, composition, gaseous exchange and its composition, importance and in plant growth	2
16.	Soil temperature; source, amount and flow of heat in soil; effect on plant growth,	2
17.	Soil reaction-pH, soil acidity and alkalinity, buffering	1
18.	effect of pH on nutrient availability	1
19.	Soil colloids, types of soil colloids and their significance	2
20.	1:1, 2:1and 2:1:1 types of layer silicates, their structure and characteristics, sources of charges on soil colloids.	2
21.	Cation and anion exchange phenomenon and factors influencing ion exchange, Base saturation	1

Lecture Schedule Practical

S. No	Topic	No. of lecture
1.	Study of Soil Profile in field	1
2.	Study of soil sampling tools, Collection of representative sample, its processing and storage	2
3.	Study of soil forming rocks and minerals	2
4.	Determination of bulk density of undisturbed soil by core sampler method.	1
5.	Determination of bulk density of disturbed soil by R D bottle methods	1
6.	Determination of particle density of soil by R D bottle and computation of porosity of soil	1
7.	Determination of lower and upper plastic limit of soil	1
8.	Determination of field capacity, permanent wilting point of soil and WHC	2
9.	Determination of soil texture by feel and Bouyoucos Methods.	1
10.	Determination of soil pHand electrical conductivity	1
11.	Determination of cation exchange capacity of soil	2
12.	Determination of soil colour by munsell colour chart	1

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1. Boul S.W., Hole R.D., McCracken and Southard R.J. (1998).Soil genesis and classification Fourth Ed Panima Publishing corporation, New delhi.
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11. Richards, L.A. (1960) Diagnosis and improvement of saline and alkali soils., USDA agriculture Hand book 60, Washington D.C., USA
12. Gupta, I.C. & Sharma, S.K. (1988) Crop production in salt affected soils, Oxford and IBH Publication, New Delhi.
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SSAC-121	**Agricultural Microbiology (Course to be shared with Plant Pathology)**	**2(1+1)**

THEORY

Introduction to microbial world: Prokaryotic and eukaryotic microbes. Sterilization, disinfection, pasteurization and Koch's postulates. Bacteria: cell structure, growth, Gram positive and Gram negative bacteria, chemoautotrophy and photoautotrophy. Bacterial genetics: Genetic recombination: transformation, conjugation and transduction, plasmids, transposon. Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles. Biological nitrogen fixation: symbiotic, associative and asymbiotic. Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere. Microbes in human welfare: silage production, bio-fertilizers, bio-pesticides, bio-fuel production and biodegradation of agro-wastes.

PRACTICAL

Introduction to microbiology laboratory and its equipments. Microscope: parts, principles of microscopy, resolving power and numerical aperture. Methods of sterilization. Nutritional media and their preparations. Methods of isolation and purification of microbial cultures. Isolation of *Rhizobium, Azotobacter* and BGA. Staining and microscopic examination of microbes. Enumeration of microbial population in soil- bacteria, fungi and actinomycetes.

Lecture Schedule: Theory

S.No.	Topic	No. of lectures
1.	Introduction to microbial world: Prokaryotic and eukaryotic microbes.	1
2.	Sterilization, disinfection and pasteurization and Koch's postulates.	1
3.	Bacteria: cell structure, growth, Gram positive and Gram negative bacteria, chemoautotrophy and photoautotrophy.	2
4.	Bacterial genetics: Genetic recombination: transformation, conjugation and transduction, plasmids, transposon.	3
5.	Role of microbes in soil fertility and crop production: Carbon, Nitrogen, Phosphorus and Sulphur cycles.	3
6.	Biological nitrogen fixation: symbiotic, associative and asymbiotic.	2
7.	Azolla, blue green algae and mycorrhiza. Rhizosphere and phyllosphere.	1
8.	Microbes in human welfare: silage production,	1
9.	Bio-fertilizers, bio-pesticides and bio-fuel production	1
10.	Biodegradation of agro-wastes.	1

Lecture Schedule: Practical

S.No.	Topic	No. of lectures
1.	Introduction to microbiology laboratory and its equipments.	1
2.	Microscope: parts, principles of microscopy, resolving power and numerical aperture.	2
3.	Methods of sterilization.	1
4.	Nutritional media and their preparations.	3
5.	Methods of isolation and purification of microbial cultures.	3
6.	Isolation of *Rhizobium, Azotobacter* and BGA..	2

7.	Staining and microscopic examination of microbes.	2
8.	Enumeration of microbial population in soil- bacteria, fungi and actinomycetes	2

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5. Rao, N.S. 2000. Soil Microbiology. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
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7. Sharma, P.D. 2010. Microbiology. 3rd edition Rastogi Publishers, Meerut
8. Dube H.C. 2007. A Text Book of Fungi, Bacteria & Viruses. 3rd ed. Agrobios India, Jodhpur.
9. Agrios, G.N. 2005. Plant Pathology. 5th ed. Academic Press, New York.

SSAC-221	**Problematic soils and their Management**	**2(1+1)**

Theory

Quality and health of cultivated soils. Distribution of problem soils in different agro ecosystem of India. Their categorization based on properties. Reclamation and management of problem soils, Acid soils and highly and low permeable soils.

Bio-remediation of problem soils through multipurpose trees (MPTs).Land capability classification, land suitability classification.

Irrigation water – quality and standards. Utilization of poor quality water in agriculture.

Practical's

*Visual diagnosis of problem 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

- Determination of $CaCO_3$ in calcareous soils
- Lime requirements of acid soil and gypsum requirements of sodic soil.
- Computation of SAR and RSC of irrigation water

LECTURE SCHEDULE – THEORY

S. No	Topic	No. of lecture
1.	Soil quality- indicators and major factors affecting the soil quality, soil health	2
2.	Distribution of problem soils in different agro-ecosystem of India.	1
3.	Categorization of problem soils based on properties	1
4.	Reclamation and management of salt affected soils	3
5.	Reclamation and management of acid soils	1
6.	High and low permeable soils and their management	1
7.	Bio remediation of soils through multipurpose trees (MPTs),	1
8.	Land capability classification	1
9.	Land suitability classification.	1
10.	Irrigation water – quality, classification and standards	3
11.	Utilization of poor quality water in agriculture	1

LECTURE SCHEDULE – PRACTICAL

S. No.	Topic	No. of lecture
1.	Visual diagnosis of problem soils	**2**
2.	Determination of Ca^{++} and Mg^{++} in soil	**1**
3.	Determination of Ca^{++} and Mg^{++} in ground water	**1**
4.	Determination of Potassium in ground water and Soil	**1**
5.	Determination of sodium in ground water and Soil	**1**
6.	Determination of $CaCO_3$ in calcareous soil	**1**
7.	Determination of $CO3^{--}$ and $HCO3^{-}$ in ground waters	**1**
8.	Determination of $CO3^{--}$ and $HCO3^{-}$ in soil	**1**
9.	Determination of chloride in ground waters and in soil	**2**
10.	Determination of sulphate ($SO4^{--}$) in ground waters	**1**
11.	Determination of sulphate ($SO4^{--}$) in soil	**1**

12	Determination of gypsum requirement of sodic soil	**1**
13.	Determination of lime requirement of acid soil	**1**
14.	Computation of SAR and RSC of irrigation water	**1**

Suggested Readings

1. Bear FE. 1964. *Chemistry of the Soil*. Oxford & IBH.
2. Jurinak JJ. 1978. *Salt-affected Soils*. Department of Soil Science & Biometeorology. Utah State Univ.
3. USDA Handbook No. 60. 1954. *Diagnosis and improvement of Saline and Alkali Soils*. Oxford & IBH.
4. Abrol, I.P. and Dhurva narayana, V.V. (1998) Technologies for wasteland development, ICAR, New Delhi-110012
5. Cirsan Paul, J.(1985) Principles of remote sensing. Longman, New York.
6. Richards, L.A. (1954). Diagnosis and improvement of saline and alkali soils. USDA Hand book No. 60, Washington, DC USA.
7. Somani, L.L. and Totawat, K.L. (1993). Management of salt affected soils and waters. Agrotech publishing Academy, Udaipur.
8. Agarwal, R.R., Yadav, J.S.P. and Gupta, R.N. (1982). Saline Alkali soils of India, ICAR, New Delhi.
9. ISSS (2015) Fundamentals of Soil Science, Div. of Soil Science, IARI, New Delhi

SSAC-311	**Manures, fertilizers and Soil Fertility Management**	**3(2+1)**

Theory

Introduction and importance of organic manures, properties and methods of preparation of bulky and concentrated manures. Green/leaf manuring. Soil organic matter , composition, properties and influences of soil fertility, Humic substances – nature and properties.

Chemical fertilizers: classification, specification and properties of major nitrogenous, phosphatic, potassic fertilizers, secondary & micronutrient fertilizers, Complex fertilizers, nano fertilizers Soil amendments, Fertilizer Storage, Fertilizer Control Order.

History of soil fertility and plant nutrition. criteria of essentiality. Forms of nutrients in soil, role, deficiency and toxicity symptoms of essential plant nutrients, Mechanisms of nutrient transport to plants, factors affecting nutrient availability to plants. Soil fertility evaluation, Soil testing. Critical levels of different nutrients in soil. Indicator plants. Methods of fertilizer recommendations to crops. Factor influencing nutrient use efficiency (NUE), Integrated nutrient management.

Lecture Schedule - Theory

S. No	Topic	No. of lecture
1.	Introduction and importance of organic manures	1
2.	Classification of organic manures	1
3.	Properties and methods of preparation of bulky manures.	2
4.	Properties and methods of preparation of concentrated manures.	2
5.	Green/leaf manuring.	1
6.	Soil organic matter , composition, properties and influences of on soil fertility,	2
7.	Humic substances – nature and properties.	1
8.	Chemical fertilizers: classification,	1
9.	Major Nitrogenous fertilizers (Urea, Ammonium sulphate, CAN) - Chemistry of manufacturing and fate in soil	2
10.	Major Phosphatic fertilizers(SSP, TSP and DAP)- Chemistry of manufacturing and fate in soil	2
11.	Major Potassic fertilizers (MOP and Potassium sulphate) - Chemistry of manufacturing and fate in soil	1
12.	Secondary & micronutrient fertilizers sources and application	1
13.	Complex fertilizers, nano fertilizers sources and application	1
14.	Soil amendments, Fertilizer Storage, Fertilizer Control Order.	2
15.	History of soil fertility and plant nutrition	1
16.	Criteria of essentiality. Forms of nutrients in soil,	1
17.	role, deficiency and toxicity symptoms of essential plant nutrients,	2
18.	Mechanisms of nutrient transport to plants	1
19.	Factors affecting nutrient availability to plants	1
20.	Soil fertility evaluation	2
21.	Soil testing. Critical levels of different nutrients in soil.	1
22.	Indicator plants. Methods of fertilizer recommendations to crops.	1
23.	Factor influencing nutrient use efficiency (NUE),	1
24.	Integrated nutrient management.	1

Lecture Schedule- Practical

Introduction of analytical instruments and their principles, Estimation of soil organic carbon, Estimation of available N in soils. Estimation of soil extractable P in soils. Estimation of

exchangeable K; Ca and Mg in soils . Estimation of soil extractable S in soils.. Estimation of DTPA extractable Zn in soils. Estimation of N in plants. Estimation of P in plants. Estimation of K in plants. Estimation of S in plants.

S. No	Topic	No. of lecture
1.	Introduction of analytical instruments and their principles	2
2.	Determination of organic carbon in soil	1
3.	Determination of available nitrogen in soil	1
4.	Determinationof soil extractable phosporus	2
5.	Determination of exchangeable potassium in soil	1
6.	Determination of soil extractable sulphur in soil	2
7.	Determination of available DTPA extractable -zinc in soil	1
8.	Determination of Ca+Mg in soil	1
9.	Rapid plant tissue test- N, P and K	2
10.	Estimation of N,P, K and S in plant	3

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6. Jackson, M.L. (1973) Soil chemical analysis, Prentice Hall of India, Pvt. Ltd New Delhi
7. Piper, C.S. (1950) Soil and Plant analysis, .Hans publications, Bombay
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14. Tandon, H.L.S. (1989). Soil water and fertilizers analysis, Fertilizer Development and Consultant organization, New Delhi

15. FAI. (1999). Fertilizer (Control) Order, 1985 and the essential commodities Act, 1995. FAI, New Delhi, pp. 203.

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Statistics, Computer Science, Mathematics and English (Name to be rechristened as Department of Basic Sciences and Humanities) –

Statistics, Computer Science, Mathematics and English - Annexures-XIII (1) to XIII (4)

1	STAT-211	Statistical Methods	2(1+1)
2	AGRINFO-211©	Agricultural Informatics	2(1+1)
3	MATHS-111	Elementary Mathematics	2(2+0)
4	ENG-111	Comprehension & Communication Skills in English (Gradial course)	2(1+1)

Elementary Mathematics

MATHS-111	**Elementary Mathematics**	**2(2+0)**

Straight lines : Distance formula, section formula (internal and external division), Change of axes (only origin changed), Equation of co-ordinate axes, Equation of lines parallel to axes, Slope intercept form of equation of line, Slope-point form of equation of line, Two point form of equation of line, Intercept form of equation of line, Normal form of equation of line, General form of equation of line, Point of intersection of two st. lines, Angles between two st. lines, Parallel lines, Perpendicular lines, Angle of bisectors between two lines, Area of triangle and quadrilateral.Circle: Equation of circle whose centre and radius is known, General equation of a circle, Equation of circle passing through three given points, Equation of circle whose diameters is line joining two points (x_1, y_1) and (x_2, y_2), Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$. Differential Calculus : Definition of function, limit and continuity, Simple problems on limit, Simple problems on continuity, Differentiation of $x^n, e^x, \sin x$ & $\cos x$ from first principle, Derivatives of sum, difference, product and quotient of two functions, Differentiation

of functions of functions (Simple problem based on it), Logarithmic differentiation (Simple problem based on it), Differentiation by substitution method and simple problems based on it, Differentiation of Inverse Trigonometric functions. Maxima and Minima of the functions of the form $y = f(x)$ (Simple problems based on it).

Integral Calculus : Integration of simple functions, Integration of Product of two functions, Integration by substitution method, Definite Integral (simple problems based on it), Area under simple well-known curves (simple problems based on it).

Matrices and Determinants: Definition of Matrices, Addition, Subtraction, Multiplication, Transpose and Inverse up to 3rd order, Properties of determinants up to 3rd order and their evaluation**.**

S. N.	Topics	No. of Lectures
1.	Straight lines	1
2.	Distance formula	1
3.	section formula	1
4.	Change of axes	1
5.	Equation of co-ordinate axes, Equation of lines parallel to axes	1
6.	Slope intercept form of equation of line, Slope-point form of equation of line	1
7.	Two point form of equation of line, Intercept form of equation of line	1
8.	Normal form of equation of line, General form of equation of line,	1
9.	Point of intersection of two st. lines,	1
10.	Angles between two st. lines, Parallel lines, Perpendicular lines	1
11.	Angle of bisectors between two lines, Area of triangle and quadrilateral	1
12.	Circle: Equation of circle whose centre and radius is known, General equation of a circle,	1
13.	Equation of circle passing through three given points,	1
14.	Equation of circle whose diameters is line joining two points (x_1, y_1) (x_2, y_2)	1
15.	Tangent and Normal to a given circle at given point (Simple problems), Condition of tangency of a line $y = mx + c$ to the given circle $x^2 + y^2 = a^2$	1
16.	Functions, Evaluation of Functions, Operations with functions	2

17.	Limits, continuity, $\lim_{x\to a}\frac{x^n-a^n}{x-a}$ $\lim_{x\to 0}\frac{\sin x}{x}$, $\lim_{n\to\infty}\left(1+\frac{1}{n}\right)^n$	4
18.	Problems on continuity	1
19.	Differentiation of $x^n, e^x, \sin x$ & $\cos x$ from first principle	2
20.	differentiation of sum and product of functions	1
21.	Quotient Rule, function of functions	2
22.	Differentiation of function of functions, Parametric Equation	2
23.	Logarithmic differentiation	1
24.	Differentiation of Inverse Trigonometric functions	1
25.	Successive differentiation, Maxima and minima	2
26.	Integration Formulae	1
27.	Integration by Substitution	2
28.	Integration by Parts	2
29.	Definite Integration	1
30.	Area under curves	2
31.	Matrices, Matrix Addition, equality of matrices, square matrix, identity, null matrix	2
32.	Subtraction, Scalar Multiplication, Matrix Multiplication, Transpose of a Matrix	2
33.	Determinants	1
34.	Inverse up to 3rd order	2

IB-111	**Introductory Biology (New)**	**2(1+1)**

Theory

Introduction to the living world, diversity and characteristics of life, origin of life, Evolution and Eugenics. Binomial nomenclature and classification Cell and cell division. Morphology of flowing plants. Seed and seed germination. Plant systematic- viz; Brassicaceae, Fabaceae and Poaceae. Role of animals in agriculture.

Practical

Morphology of flowering plants – root, stem and leaf and their modifications. Inflorence, flower and fruits. Cell, tissues & cell division. Internal structure of root, stem and leaf. Study of specimens and slides. Description of plants - Brassicaceae, Fabaceae and Poaceae.

ENG-111	**Comprehension & Communication Skills in English (Gradial course)**	**2(1+1)**

Theory

War Minus Shooting- The sporting Spirit. A Dilemma – A layman looks at science Raymond B. Fosdick. You and Your English– Spoken English and broken English G.B. Shaw. Reading Comprehension, Vocabulary-Antonym, Synonym, Homophones, Homonyms, often confused words. Exercises to Help the students in the enrichment of vocabulary based on TOEFL and other competitive examinations. Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement, Transformation, Synthesis, Direct and Indirect Narration. Written Skills: Paragraph writing, Precise writing, Report writing and Proposal writing. The Style: Importance of professionalwriting.PreparationofCurriculumVitaeandJobapplications.SynopsisWriting.Interviews: kinds, Importance and process.

Practical

Listening Comprehension : Listening to short talks lectures, speeches (scientific, commercial and general in nature). Oral Communication: Phonetics, stress and intonation, Conversation practice. Conversation : rate of speech, clarity of voice, speaking and Listening, politeness & Reading skills: reading dialogues, rapid reading, intensive reading, improving reading skills. Mock Interviews: test inginitiative, team spirit, leadership, intellectual ability. Group Discussions.

Theory:

S. No.	Topics	No. of Lectures
1.	War Minus Shooting- The sporting Spirit.	1
2.	A Dilemma – A layman looks at science Raymond B. Fosdick.	1
3.	You and Your English– Spoken English and broken English G.B. Shaw. Reading Comprehension,	1
4.	Vocabulary-Antonym, Synonym,	1
5.	Homophones, Homonyms, often confused words	1
6.	Exercises to Help the students in the enrichment of	1

	vocabulary based on TOEFL and other competitive examinations.	
7.	Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement	1
8.	Transformation, Synthesis,	1
9.	Direct and Indirect Narration.	1
10.	Written Skills: Paragraph writing,	1
11.	Precise writing, Report writing and Proposal writing.	1
12.	The Style: Importance of professional writing.	1
13.	Preparation of Curriculum Vitae and Job applications.	1
14.	Synopsis Writing.	1
15.	Interviews: kinds	1
16.	Importance and process.	1

Practical:

S. N.	Topics	No. of Lectures
1.	Listening Comprehension : Listening to short talks lectures	1
2.	speeches (scientific, commercial and general in nature).	1
3.	Oral Communication: Phonetics,	1
4.	stress and intonation,	1
5.	Conversation practice.	1
6.	Conversation : rate of speech, clarity of voice,	1
7.	Functional grammar: Articles, Prepositions, Verb, Subject verb Agreement	1
8.	speaking and Listening, politeness	1
9.	Reading skills: reading dialogues,	1
10.	rapid reading,	1
11.	intensive reading,	1
12.	improving reading skills..	1
13.	Mock Interviews: test inginitiative,	1
14.	team spirit	1
15.	leadership, intellectual ability.	1
16.	Group Discussions	1

STAT-211	Statistical Methods	2(1+1)

Theory

Introduction to Statistics and its Applications in Agriculture, Graphical Representation of Data, Measures of Central Tendency & Dispersion, Definition of Probability, Addition and Multiplication Theorem (without proof). Simple Problems Based on Probability. Binomial & Poisson Distributions, Definition of Correlation, Scatter Diagram. Karl Pearson's Coefficient of Correlation. Linear Regression Equations. Introduction to Test of Significance, One sample & two sample test t for Means, Chi-Square Test of Independence of Attributes in 2□□2 Contingency Table. Introduction to Analysis of Variance, Analysis of One Way Classification. Introduction to Sampling Methods, Sampling versus Complete Enumeration, Simple Random Sampling with and without replacement, Use of Random Number Tables for selection of Simple Random Sample.

Practical

oGraphical Representation of Data. Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles. Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data). Moments, Measures of Skewness & Kurtosis (Ungrouped Data). Moments, Measures of Skewness & Kurtosis (Grouped Data). Correlation & Regression Analysis. Application of One Sample t-test. Application of Two Sample Fisher's t-test. Chi-Square test of Goodness of Fit. Chi-Square test of Independence of Attributes for 2□□2 contingency table. Analysis of Variance One Way Classification. Analysis of Variance Two Way Classification. Selection of random sample using Simple Random Sampling.

THEORY		
S. No.	**Topics**	**No. of Lectures**
1.	Introduction to Statistics and its Applications in Agriculture,	**2**
2.	Graphical Representation of Data, Measures of Central Tendency & Dispersion,	**2**
3.	Definition of Probability, Addition and Multiplication Theorem (without proof).	**2**
4.	Simple Problems Based on Probability.	**2**
5.	Binomial & Poisson Distributions,	**2**

6.	Definition of Correlation, Scatter Diagram.	**2**
7.	Karl Pearson's Coefficient of Correlation. Linear Regression Equations.	**2**
8.	Introduction to Test of Significance,	**2**
9.	One sample & two sample test t for Means,	**2**
10.	Chi-Square Test of Independence of Attributes in 2□□2 Contingency Table	**2**
11.	Introduction to Analysis of Variance,	**2**
12.	Analysis of One Way Classification.	**2**
13.	Introduction to Sampling Methods,	**2**
14.	Sampling versus Complete Enumeration,	**2**
15.	Simple Random Sampling with and without replacement,	**2**
16.	Use of Random Number Tables for selection of Simple Random Sample.	**2**

Practical:

THEORY		
S. N.	**Topics**	**No. of Lectures**
1.	Graphical Representation of Data.	**1**
2.	Measures of Central Tendency (Ungrouped data) with Calculation of Quartiles,	**1**
3.	Deciles & Percentiles.	**1**
4.	Measures of Central Tendency (Grouped data) with Calculation of Quartiles, Deciles & Percentiles.	**1**
5.	Measures of Dispersion (Ungrouped Data). Measures of Dispersion (Grouped Data).	**1**
6.	Moments,	**1**
7.	Measures of Skewness & Kurtosis (Ungrouped Data).	**1**
8.	Moments, Measures of Skewness & Kurtosis (Grouped Data).	**1**
9.	Correlation & Regression Analysis.	**1**
10.	Application of One Sample t-test.	**1**
11.	Application of Two Sample Fisher's t- test.	**1**

12.	Chi-Square test of Goodness of Fit.	**1**
13.	Chi-Square test of Independence of Attributes for 2□□2 contingency table.	**1**
14.	Analysis of Variance One Way Classification.	**1**
15.	Analysis of Variance Two Way Classification.	**1**
16.	Selection of random sample using Simple Random Sampling.	**1**

AGRINFO-211©	**Agricultural Informatics**	**2(1+1)**

Theory

Introduction to Computers, Anatomy of Computers, Memory Concepts, Units of Memory, Operating System, types of operating system, Applicationsof MS-Officefor creating, Editing and Formatting adocument, Data presentation, tabulation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types, creating database, uses of DBM Sin Agriculture, Internet and World Wide Web(WWW),Concepts, components and creation ofweb, HTML, XML coding.

Computer Programming: GeneralConcepts,Introductionto programming languages, concepts and standard input/output operations, Variables and Constants, Operators and Expressions, Flow of control, Inbuilt and User defined functions, programming techniques for agriculture.

e-Agriculture: concepts, design and development, application of innovative ways to use information and communication technologies (IT) in Agriculture. ICT for Data Collection, IT application for computation of waterand nutrient requirement of crops etc., Computer-controlled devices (automated systems) for Agri-input management, Smart phone mobile appsin Agriculture for farm advises, market price, post-harvest management etc; Introduction of DSS and its role in agriculture, Introduction and role of expert system in agriculture.

Practical

Study of Computer Components and accessories. Introduction of different operating systems such as windows, Unix, Linux, Creating, Files &Folders, File Management. Use of MS-WORD and MS Powerpoint forcreating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, arttool, graphics, template & designs. MS-EXCEL – Creating as preadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system.

Introduction to World Wide Web (WWW) and its components, Introduction to HTML,

Use of smart phones and their devices in agro-advisory and dissemination of market information.

S. NO.	Topics	No. of Lectures
1	Introduction to Computers, Anatomy of Computers	**1**
2	Memory Concepts, Units of Memory, Operating System, types of operating system	**1**
3	Applications of MS-Office for creating, Editing and Formatting a document, Data presentation	**1**
4	Tabulation and graph creation, statistical analysis, mathematical expressions, Database, concepts and types	**1**
5	creating database, uses of DBMS in Agriculture, Internet and World Wide Web (WWW), Concepts, components and creation of web, HTML, XML coding.	**1**
6	Computer Programming: General Concepts, Introduction to programming languages	**1**
7	Concepts and standard input/output operations	**1**
8	Variables and Constants	**1**
9	Operators and Expressions, Flow of control	**1**
10	Inbuilt and User defined functions, programming techniques for agriculture.	**1**
11	e-Agriculture: concepts, design and development, application of innovative ways to use information and communication technologies (IT) in Agriculture.	**1**
12	ICT for Data Collection	**1**
13	ITapplication for computation of water and nutrient requirement of crops etc.,	**1**
14	Computer-controlled devices (automated systems) for Agri-input management	**1**
15	Smart phone mobile appsin Agriculture for farm advises, market price, post-harvest management etc	**1**
16	Introduction of DSS and its role in agriculture, Introduction and role of expert system in agriculture.	**1**

PRACTICAL		
S. No.	**Topics**	**No. of Lectures**
1.	Study of Computer Components and accessories	**1**
2.	Introduction of different operating systems such as	**1**

	windows, Unix, Linux, Creating, Files & Folders,	
3.	File Management. Use of MS-WORD	**1**
4.	MS Powerpoint forcreating, editing and presenting as cientific Document	**1**
5.	Handling of Tabular data, animation, video tools, arttool, graphics, template & designs.	**1**
6.	MS-EXCEL –Creating as pread sheet, use of statistical tools	**1**
7.	Writing expressions, creating graphs, analysis of scientific data	**1**
8.	handling macros.	**1**
9.	MS-ACCESS: Creating Database,	**1**
10.	Preparing queries and reports, demonstration of Agri-information system.	**1**
11.	Introduction to World Wide Web (WWW) and its components, and	**1**
12.	Introduction to HTML	**1**
13.	Introduction to HTML	**1**
14.	Use of smart phones and other devices inagro-advisory	**1**
15.	Dissemination of market information.	**1**
16.	Dissemination of market information.	**1**

Remedial Courses- Annexures -XIV (1)

1	BIO-111	Introductory Biology	2(1+1)

Non-Gradial Courses - Annexures-XV (1)

		NSS/NCC/Physical Education & Yoga Practices	2(0+2)
		Educational Tour	2(0+2)

SYLLABUS

For

B.Sc. (Honours) Forestry

2018-19

FACULTY OF FORESTRY
AGRICULTURE UNIVERSITY, KOTA

SAF-111 Introduction to Forestry 2 (2+0)

Theory

Forests - definitions, role, benefits - direct and indirect. History of Forestry - definitions, divisions and interrelationships. Technical terms in forestry Classification of forests - High forests, coppice forests, virgin forest and second growth forests, pure and mixed forests - even and uneven aged stands. Forest types of India- classification. Status of forest produces in India, Important non timber forest produces and livelihood, major forest based industries. Agroforestry - farm forestry, social forestry, joint forest management - concepts, programme and objectives. Basics of forest protection. Important acts and policies related to Indian forests. Global warming - forestry options for mitigation and adaptation - carbon sequestration. Essentials of forest and tree cover expansion. Forest flora and fauna of national and regional importance, protected area networks in India and Rajasthan.

Important events/dates related to forests and environment - themes and philosophy.

Introduction to world forests - geographical distribution and their classification, factors influencing global forests distribution - productivity and increment of world forests. Forest based industries in the developed and developing countries. Trade patterns of forest based raw materials. Recent trends in forestry development in the world. National and international organizations in forestry.

Suggested Reading

Beazley, M. 1981. The International Book of Forest. London

Champion and Seth. 1968. Forest types of India.

Grebner, D.L., Bettinger, P. and Siry, J.P. 2012. *Introduction to Forestry and Natural Resources*. Academic Press. 508p (Google eBook).

Khanna, L.S. 1989. *Principles and Practice of Silviculture*. Khanna Bandhu, New Delhi.

Mitchell Beazly.1981. *The International Book of the Forest*. Mitchell Beazly Publishers, London.

Mather, A.S. 1990. *Global Forest Resources*. Belhaven, London

Persson, R. 1992. *World Forest Resources*. Periodical Experts, New Delhi.

Westoby, J. 1991. *Introduction to World Forestry*. Wiley, 240p.

SAF-121 Theory and Practice of Silviculture 3(2+1)

Theory

Definitions: Forests and Forestry- Silviculture objectives and scope of silviculture-relation with other branches of Forestry Silvics. Site factors - climatic, edaphic, physiographic, biotic and their interactions. Trees and their distinguishing features, growth and development. Root growth- fine root/functional root production- Direct and indirect benefits- biophysical interactions- trees and buffering functions- C sequestration potential of forests. Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration- accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

Regeneration of forests – objectives - ecology of regeneration- natural and artificial regeneration. Natural regeneration- seed production, seed dispersal, germination and establishment, requirement for natural regeneration, advance growth, coppice, root sucker, regeneration survey, natural regeneration supplemented by artificial regeneration. Artificial regeneration - object of artificial regeneration - advantages. Factors governing the choice of regeneration techniques. Tree planting- Sowing v/s planting different kinds of pits. Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

Practical

Acquaintance with modern silvicultural tools. Visits to different forest areas/types. Study of forest composition. Visiting plantations raised by forest department, Exercise on nursery practice- seed collection, seed pre-treatment- nursery stock preparation- field preparation- marking, alignment and stacking, pit making-planting, various tending operations- weeding, cleaning, singling, pruning, pollarding, lopping, and thinning- fertilization in trees-plant protection and sanitation measures.

Suggested reading

Baker,F.S.1950.PrinciplesofSilviculture,McGrawHill, N . Y .

Champion,H.G.andTrevor,G.1936.HandbookofSilviculture,CosmoPublication, N e w Delhi

Daniel,T.W.,Helms,J.A.,Baker,F.S.1970.PrinciplesofSilviculture,McGrawHill, N.Y.

Duryea,M.L.andLandis,T.D.(eds.)1984.ForestNurseryManual:Productionofbareroot seedlings.MartinusNijhoff/DrW.JunkPublishers.TheHague/Boston/Lancaster,386p.

Dwivedi.A.P. 1993.TextbookofSilviculture.InternationalBookDistributors.

Evans,JE.1982.PlantationForestryintheTropics.TheEnglishLanguageBookSocietyandClarendonPress–Oxford

Gunter, S., Weber, M,M Stimm, B and Mosandl, R. 2011. Silviculture inthe Tropics. Springer-Verlag- Berlin.

Haig, I. T. Huberman, M . A. andAungDin, U. 1986. TropicalSilviculture,Vol. I andII.

Food andAgriculture Organization oftheUnited Nations Rome andPeriodical Experts BookAgency, D-42, Vivek Vihar,Delhi–110032.

Khanna,L.S.1989. Principles and Practice of Silviculture. KhannaBandhu, 7TilakMarg, DehraDun

Kostler,J.1956. Silviculture.InternationalBookDistributors,P.O.Box4.DehraDun

Lal,J.B.2003.TropicalSilviculture,NewImperatives:NewSystems,InternationalBookDistributs, P.O.Box4.DehraDun

Smith,D.M.1986.The Practice of Silviculture,Edn8.NewYork,JohnWiley.

SAF-122 Forest Protection 3(2+1)

Theory

Introduction – Importance of protection in Indian Forestry – classification of injurious agencies. Injury to forest due to fires, causes and character of forest fires – fire prevention activity – fire suppression – fire fighting equipments – fire control policy and objectives. Fire fighting in other countries. Forest grazing, grazing capacity, impacts of overgrazing, grazing management, Forest mining, impacts of mining, reclamation of mining area, Injury to forest due to man, lopping – cutting for fuel wood – Encroachment- different types, control of encroachment illegal felling of trees- method of control legislation. Damage by wild animals, forest weeds and weed management, management of woody climbers, parasites and epiphytes. Damages caused by Frost, flood, landslides, drought, etc. and protection measures.

Importance of Forest Pathology, tree disease classification, Principles of tree disease management, - Causes and symptoms- losses due to forest tree diseases, root diseases (wilt, root- and butt rot), stem diseases (heart rots, stem blisters, rusts, stem wilt, cankers, pink diseases, gummosis, water blister) and foliar diseases (rust, powdery mildew, leaf spot, leaf and twig blight, abnormal leaf fall, needle blight etc.) Etiology, symptoms, mode of spread, epidemiology and management, including chemical, biological, cultural and silvicultural practices. Nursery diseases and their management. Disease due to physiological causes. Abiotic diseases.

Forest Entomology in India. Methods and principles of pest control: Mechanical, physical, silvicultural, legal, biological and chemical. Principles and techniques of Integrated Pest Management in forests. Classification of forest pests: types of damages and symptoms; factors for outbreak of pests. Nature of damage and management: Insect pests of forest seeds, forest nursery and standing trees of timber yielding species of natural forest and Plantation forest species. Insect pests of freshly felled trees, finished timbers and their management.

Practical

Visit to forest areas with fire damages, Studying fire registers as records, studying encroachments and problems caused due to disturbance-visit to illegally felled areas- Visit to fire station, Study and acquaint with machinery used for fire control, identification of weeds, parasites and epiphytes. Observation of symptoms in laboratory and in forests - examination of scrapings - host-parasite relationships - causal organisms of above forest diseases. Examination of cultures of important pathogens. Visit to nurseries and plantations. Insect pests of forest seeds; forest nurseries; standing trees; freshly felled trees and finished products. Survey and identification of invertebrate fauna from forest areas. Methods of isolating soil invertebrate macro and micro fauna. Insecticides and their formulations, plant protection appliances.

Suggested Readings

Agrios, G.N. (1997). Plant Pathology. 4thEdn, Horcourt Asia Pvt. Ltd., Singapore.

Bakshi, B.K. (1976), Forest Pathology; Principles and Practices in Forestry. Pub. Comptroller of Publications, Delhi. 400p.

Basher, A.E.S. (1983).Forest Fires and Their Control. Gulab Primlani Amerind Publishing, New

Boyce, J.S. (1961). Forest Pathology, 3rd edition. McGraw-Hill. New York, New York. 572 pp

Brown, A.A and Davis, K.P. (1973). Forest Fire Control and Use. Mc Graw Hill Book Co. New York. Delhi.159p.
Devasahayam, H.L. and Henry, L.D.C. (2009). Illustrated Plant Pathology- Basic Concepts. New India Publishing Agency
Elton, C. S. (2000). The Ecology of Invasions by Animals and Plants. University of Chicago Press.
Fuller, M. (1991). Forest Fires. Wiley Nature Editions, New York.
Ghadekar, S.R. (2003) Meteorology. Agromet Publishers, Nagpur
Hal, R.B. (1990). Principles and Procedure of Range Management. International Book Distributors, Dehra Dun.
Johnson, A.E and Miyanishi, K. (2001). Forest Fires: Behavior and Ecological Effects. Academic Press.
Khanna, L.S. (1988). Forest Protection. Khanna Bandhu, Dehra Dun.206p.
Lenka, D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi
Luna, R.K. (2007). Principles and Practices of Forest Fire Control. International Book Distributors, Dehradun.466p.
Mavi, H.S. (1994) Agrometerology. Oxford &IBH, New Delhi
Mohanan, C. (2011). Macro fungi of Kerala, KFRI, Peechi.p.597
Negi, S.S. (1999). Handbook of Forest Protection. International Book Distributors.271p.
Pathak, V.N., Khatri, N.K. and Manish Pathak. (2000). Fundamentals of Plant Pathology. Eds.Agribios (India), Jodpur. 356 p.
Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,
Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg
Singh, R.S (2002).Introduction Principles of Plant Pathology. Oxford & IBH, New Delhi
Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR, New Delhi

SAF-211 Principles of Agroforestry 3(2+1)

Theory

Land use and land capability classification. Overview of the Agriculture scenario – its structure and constraints. Concept of sustainable agriculture and land use management. Paradigm shift in Agriculture development- impacts of green revolution –Agroforestry – definition and scope – rising demands of fuel wood, fodder and timber. Social, ecological, and economic reasons for agroforestry. History of agroforestry. Components of Agroforestry- Provisioning and regulator services of agroforestry- Nutrient cycling, Soil improvement, Increased production and productivity, Microclimate amelioration and carbon sequestration – Tree-crop interaction in agroforestry– Definition, kind of interaction – Positive interactions- complimentarity - compatibility - mutualism, commensalism - Negative interactions – allelopathy and competition- Interaction management– Classification of agroforestry systems –Agro-forestry systems in India.. overview of agro-forestry around the world

Practical

Visit to social /Urban /Community forestry plantations and study their impact on socio – economic status of rural people- Traditional agroforestry systems in the country and visits to some of the local agroforestry systems. Agroforestry systems in different agroecological zones-

their structural and functional features. Visit to on farm agroforestry models. Studies on fodder banks and live fences. Studies on light and below ground interactions in agroforestry systems- MPTs and Nitrogen fixing trees in agroforestry- Studies on allelopathy- Land capability classification of various topographic regions- Visit to industrial plantations.

Suggested reading

Huxley, P.A. 1983 (ed). Plant Research and Agroforestry, ICRAF, Nairobi, Kenya.

Huxley, P. 1999. Tropical Agroforestry. Wiley: 384p.

Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p

Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi.

Nair, P.K.R, Rao MR, and Buck, L.E (eds), 2004. New Vistas in Agroforestry: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.

Nair, P.K.R. 1993. An Introduction to Agroforestry. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Nair, P.K.R. Agroforestry Systems in the Tropics. Springer. 680p.

Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. J. Plant Nutr. Soil Sci. 172: 10–23.

Pathak P.S. and Ram Newaj (eds.) 2003. Agroforestry: Potentials and Opportunities. Agrobios, Jodhpur.

SAF-212 Forest Mensuration 3(2+1)

Theory

Forest Mensuration - Definition and objectives - Scales of measurement- Units of measurements - Precision, bias and accuracy- Diameter and girth measurements- Breast height measurements instruments used- Measurement of height-Definitions- Methods of measurement of height-occular-non instrumental and instrumental methods- Sources of error in height measurements-leaning trees. Tree stem form-Metzgr's theory –form factor- types of form factor-form height for quotient-form class. Volume measurements of standing trees-logs-branch wood- formulae-involved Definitions - Volume tables preparation of volume tables-graphical method-regression method- Determination of growth of trees- Increment-CAI & MAI- increment percent-increment borer- Stump analysis- Stem analysis. Estimation of biomass Measurement of tree crops-objects-crop diameter-crop height-crop age-crop volume.

Practical

Determination of pace length- Measurements of diameter-girth and basal area of trees using Callipers, Tape, Ruler, Penta Prism Tree Calliper etc. Measurement of height using non instrumental method- Preparation and use of simple height measuring instruments- Christens Hypsometer-Smithies Hypsometer- Modified Smithies Hypsometer-Measurement of tree height using instrumental methods- Abneys level- Haga altimeter- Relaskop- Clinometer- Blume-leiss Hypsometer-Laser Hypsometer- Volume determination of standing and felled trees. Exercise on Stump analysis. Exercise on stem analysis-Annual ring counting using ring borer. Preparation of volume tables- local volume table.

Suggested reading

Chaturvedi, A.N and L.S. Khanna. 2011. Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.

Forest mensuration: A Handbook for Practitioners. 2006. Forestry Commission Publications. 330 pp.

Husch, B., Beers, T.W. and Kershaw, J. J.A. 2002. Forest Mensuration (4th edition). John Wiley & Sons, Nature.456 pp.

Laar, V. A. and Akca, A. 2007. Forest Mensuration. Managing Forest Ecosystems. Vol.13. Springer.384pp.

Manikandan, K. and Prabhu, S. 2012. Indian Forestry. Jain Brothers. New Delhi. 590 pp.

West, P.W. 2009. Tree and Forest Measurement (2nd edition). Springer. 192pp.

SAF-221 Forest Management 3(2+1)

Theory

Definition, scope, objective and principles of forest management, organization of state forests-sustained yield-definition, principles and limitations. Sustainable forest management-criteria and indicators-Increasing and progressive yields-Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations, -objectives and uses, National working plan code -forest maps and their uses. Joint forest management-concept and principles- Modern tools in forest management. Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry- Forests and man- Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups- Gender dimensions in Community forest management. Social Forestry- definition –NCA report of 1976- need and purpose- Social Forestry for – fodder production – fuel wood – leaf manure –timber production. Integrated rural development approach – with proper marketing facility – employment generation in raising, tending and harvesting of tree crops. Place of social forestry in the national forest policy of India-role of forest department.

Practical

Visit to different forest divisions to study the various stand management aspects including thinning, felling and sale of timber. Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Field visit to JFM operational areas. Study the different field exercises for data collection for working plan.

Suggested reading

Balakathiresan,S(1986).EssentialsofForestManagement,NatarajPublishers,Dehradun.

BhattacharyaP.,KandyaA.K.andKrishnaKumar(2008).JointForestManagementinIndia,AavishkarPublisher,Jaipur.

Desai,V.(1991).ForestManagementinIndia–IssuesandProblems.HimalayaPub.House,Bombay.

Edmunds, DandWollenberg, E(2003).Essentials ofForest Management, Natraj Publishers, Dehra Dun.

JeromeLCutteretal.(1983).TimberManagement:AQuantitativeApproach.JohnWileyandSons

NationalWorkingPlanCode(2014).MoEF,NewDelhi.

Ramprakash,(1986).ForestManagement,IBD,Dehradun.

Recknagel,AandBentley.J.(1988).ForestManagement.IBD,Dehradun.

Trivedi,P,RandSudarshan,K,N.(1996).ForestManagement.Discoverypublications,NewDelhi

SAF-222 Silviculture of Indian Trees 3 (2+1)

Theory

Origin, distribution, general description, phenology, silvicultural characters, regeneration methods, silvicultural systems, stand management practices pest and diseases and economic importance of the following tree species of India. Broadleaved species: *Tectona grandis*, *Shorea robusta, Dalbergia latifolia, Dalbergia sissoo, Anogeissus spp, Terminalia spp., Santalum album, , Albizia spp, Pterocarpus marsupium, Pterocarpus santalinus, Azadirachta indica, Prosopis cinreraria, Tecomella undulata*, *Schleichera oleosa, Bombax ceiba, Butea monosperma, Mitragyna parviflora, Madhuca indica, Diospyros melanoxylon,. Quercus* spp. *Betula spp, Alnus spp, Juniperus spp,* Bamboos, canes, reeds and rattan, Conifers: *Abies pindrow, Picea smithiana, Cedrus deodara, Pinus roxburghii, Pinus wallichiana.* Fast growing MPTs: Tropical pines, *Eucalyptus spp, Casuarina equisetifolia, Leucaena leucocephala, Ailanthus spp, Grevillea robusta, Pongamia pinnata, Melia dubia, Acacia spp, Populus spp*.

Practical

Study the morphological description and field identification characteristics of trees, seeds and seedlings. Phenology, Collection of seeds. Planting and stand management practices of *Tectona grandis, , Santalum album, ,* eucalypts, acacias *Prosopis cineraria, Tecomella undulata*, S*chleichera oleosa, Bombax ceiba, Butea monosperma, Mitragyna parviflora, Madhuca indica, Pongamia pinnata*, bamboos, fast growing MPTs etc. Study the silviculture of trees in response to light, fire, drought, frost, root suckering, coppicing and pollarding, etc. Visit various problem areas and study on species suitability.

Suggested reading

Bebarta, 1999. Teak: Ecology, Silviculture, Management and profitability, IBD, Dehra Dun

Champion, H.G. and A.L. Griffith. 1989. Manual for General Silviculture for India

ICFRE booklets on tree species

Kadambi, K. 1993. Silviculture and Management of teak. Nataraj Publishers, Dehra Dun. p. 137.

Lamprecht H 1989. Silviculture in the Tropics. GTZ, GmBH, FRG

Troup, RS 1922. Silviculture of Indian Trees, Vol. 1-4, Revised and Enlarged Edition, Forest Research Institute and Colleges, Dehra Dun, 1975.

Renuka, C., Pandalai, R.C. and Mohanan, C. 2002 Nursery and silvicultural techniques for rattan, Kerala Forest research Institute.

SAF-223 Seed Technology & Nursery Management 3 (2+1)

Theory

Importance of seed in present day forestry, seed and fruit development, seed dispersal. Planning seed collection-Collection of immature fruits - Methods of seed collection. Fruit and seed handling - maintaining viability and identity- special precautions for recalcitrant seeds. Seed processing- operations prior to extraction-pre-cleaning, methods of extraction- operations after extraction- cleaning, grading and control of moisture level- factors affecting drying of orthodox seeds. Seed storage- definition- purpose, recalcitrant seeds- Harrington's rule of thumb, seed maturity- parental and annual effects. Storage condition and ageing of seeds. Storage methods - Storage containers. Seed dormancy- types of dormancy, treatments for breaking exogenous and endogenous dormancy. Seed dressing and pelleting. Seed testing - definition- ISTA rules. Sampling- seed weight- moisture- authenticity- seed health. Germination testing- germination equipment- conditions for selected species. Germination evaluation- germination testing in nursery. Indirect tests of viability. Seed Act and Seed Certification. Introduction and scope of Forest nursery. Nursery establishment - site selection – planning and layout of nursery area. Types of forest nursery, types of nursery beds, preparation of beds, fumigation. Methods of seed sowing and mulching, seedling growth and development, pricking, weeding, hoeing, rotation, organic matter supplements and cover crops, mycorrhizae, fertilization, shading, pruning, root culturing techniques, lifting windows, grading, packaging. Storing and transportation. Containerised nursery technique - advantages, disadvantages - root deformations - container designs and types/root trainers and rooting media. Conditions/practices affecting survival and early growth, acclimating containerised stock, field handling of containerised stock, planting techniques for containerized stock. Planting bare-root seedlings: advantages, disadvantages. Methods for field handling and planting bare-root stock. Containerised nursery technique- Type and size of containers. Merits and demerits of containerized nursery. Root trainer techniques- Preparation of ingredient mixture. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept.

Practical

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis; Determination of seed moisture; Seed germination test; Hydrogen peroxide test; Tetrazolium test for viability; Seed vigour and its measurements; Methods of breaking dormancy in tree seeds; Testing membrane permeability; Study of seed collection and equipments; Planning of seed collection; Seed collection; Seed extraction; Visit to seed production area and seed orchard; Visit to seed processing unit/testing laboratory; Study of seed sampling equipments. Preparation of

production and planning schedule for bare root and containerized nurseries. Nursery site and bed preparation. Pre-sowing treatments. Sowing methods of small, medium, and large sized seeds. Mother beds and transplant bed preparation- Pricking and transplanting of in transplant beds. Intermediate nursery management operations. Preparation of ingredient mixture. Filling of containers. Visit to tree nurseries.

Suggested reading

Agrawal, R.L. 1986. Seed Technology. Oxford - IBH Publishing Co. New Delhi

Ahuja, P.S. et al. 1989. Towards developing "Artificial Seeds" by shoot and root encapsulation. In: Tissue Culture and Biotechnology of Medicinal and Aromatic Plants. CIMAP, Lucknow, India, P. 22-28.

Bewely, J.D and Black, M. 1985. Seed- Physiology of development and germination

Bose, T.K; Mitra, S.K. and Sadhu, M.K. 1986 Propagation of tropical and sub tropical Horticultural crops. Naya Prakash, Calcutta

Chin, H.F. and Roberts, E.H. 1980. Recalcitrant Crop Seeds. Tropical Press Sdn. Bhd. Kuala Lumpur - 22-03, Malaysia

Duryea, M.L. and Landis, T. D. (eds.) 1984. Forest Nursery Manual: Production of Bareroot Seedlings. Martinus Nijhoff/ Dr. W. Junk Publishers, The Hague/Boston/Lancaster for Forest Research Laboratory, Oregon State University, Corvallis, 386 p.

Evans, J. 1982. Plantation Forestry in the Tropics. The English Language Book Society and Claredon Press - Oxford. 472p.

Hartmann, H.T and Kester, D.E. 1968. Plant propagation – principles and practice prentice – Hall of India Private Limited, New Delhi.

ISTA. 1993. International Rules for Seed Testing Rules. International Seed Testing Association, Zurich, Switzerland, 1993.

Khullar, P. et. al. 1992. Forest Seed. ICFRE, New Forest, Dehra Dun

Leadem, C.L. 1984. Quick Tests for Tree Seed Viability. B.C. Ministry of Forests and Lands, Canada.

Liegel, L.H. and Venator, R. 1987. A Technical Guide for Forest Nursery Management in the Carribean and Latin America. Gen. Tech. Rep. SO-67, New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 156p.

May, J.T., Belcher, Jr. E. W., Cordell, C.E., Filer, Jr. T. H., David South, and Lantz. C. W. 1985. Southern Pine Nursery Handbook,USDA Forest Service, Southern Region, Cooperative Forestry

Mehta, A.R and Bhatt, P.N. 1990. Hand book of plant tissue and all cultures. Academic book centre, Ahmedabad

Napier, I. and Robbins, M. 1989. Forest Seed and Nursery Practice in Nepal. Nepal-UK Forestry Research Project, Kathmandu

Prakash, R. 1990. Propagation Practices of Important Indian Trees. International Book Distributors, Dehra Dun.

Schmidt, L. 2000. Guide to Handling Tropical and Subtropical Forest Seed. Danida.

SAF-311 Forest Laws, Legislation and Policies 2 (2+0)

Theory

National forest policies-scope and importance- comparative analysis of all forest policies -Indian judicial system- Legal definitions, application of penal code to forests, general principles of

criminal law, legal principles of punishment, criminal procedure code, the law of evidence and the Indian Evidence Act, 1872 as applied to forestry matters. Indian Forest Act, 1927 general provisions, Code of Civil procedure, 1908. Forest (Conservation) Act, 1980, National Green Tribunal (NGT), Forest Dwellers Act 2006 , Wild life (Protection) Act,1972, Brief description about other major forest laws of regional, national and international significance. Rajasthan State Forest Acts and Rules. Discussion of court verdicts on issues of utmost importance to conservation.

Suggested readings

Dutta, R. and Yadav, B. (2012). Supreme Court on Forest Conservation. Universal Law Publishing Co., New Delhi, India

Joy, P. P. (2012). Set up your criminal practice. Swamy Law House, Ernakulam

Shetty, B. J. (1985), A Manual of Law for Forest Officers, Sharda Press, Mangalore

Takwani, C. K. T and Thakker, M. C. (2012). Takwani Criminal Procedure. Lexis Nexis Butterwarths Wadhwa, Nagpur

Varghese, M. I. (2012). Treatise on Forest Laws of Kerala. Swamy Law house, Ernakulam.

SAF-312 Climate Science 3(2+1)

Theory

Definition, aim and scope: Climate, climatology. , Factors and elements of weather and climate. Agro climatic zones Composition and structure of atmosphere. Air and soil temperature regimes, atmospheric humidity, types of clouds and precipitation, hails and frost. Monsoon and rainfall pattern in India. Cyclones, anticyclones and thunder storms. Solar radiations components and effect on plant growth. Effect of weather and climate on the growth and development of crops. Climatic normals for crops and trees. Climatic zones of India. Evaporation and transpiration.

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest. Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on forests and agro-forestry- Climate resilient forestry. Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change. National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer. Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere.

Suggested reading

Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Mavi, H.S. (1994) Agrometerology . Oxford &IBH, New Delhi

Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,

Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg

Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR , New Delhi.

SAF-313 Forest Extension and Community Forestry 3(2+1)

Theory

Forest Extension: Introduction- human behaviour and psychology. Concept, scope, principles, philosophy and objectives of extension education and forestry extension education. Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Forestry extension: process, principles and types of education, Formal, informal non-formal education. People's participation in Forestry programmes. Elements of extension education, man himself man's environment and man's created devices. Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Van Vigyan Kendras, Technology Assessment and Refinement Programme (TARP) of ICAR/ICFRE. Communication: meaning, definition, elements and selected models. Audio-visual aids: importance, classification and selection. Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods. Scope and importance of Participatory Rural Appraisal (PRA). Rural social groups, primary and secondary groups, formal, informal group, temporary, permanent groups, references group, classification of group.

Community Forestry: Introduction to the concept of forestry as a common property resource– Definition, Scope and necessity of community forestry. Forests and man: Forestry in support to agriculture, animal husbandry and horticulture – development of cottage industry in rural environment-NFP 1988 and the importance of people in forest conservation. Community forest management, Community forest development, social economical and environmental aspects, Community forest development through NGOs, civil societies, citizen groups. Gender dimensions in Community forest management. Social Forestry- definition, need and purpose, historic development. Social Forestry for fodder production, fuel wood, leaf manure, timber production, NTFPS. Integrated rural development approach with proper marketing facility, employment generation in raising, tending and harvesting of tree crops. Joint Forest management: concept, legislation, rules, importance. Case studies of JFM implementation-problems and prospects, Microplan Preparation. JFMs, FDCs, VFCs, CBOs, NGOs and co-operative societies. How to organize, seminars, workshops, exhibition, trainings, symposia etc.

Practical

Visits to study structure, functions, linkages and extension programmers of KVKs or ICFRE institutes/voluntary organizations/Mahila Mandal/Village Panchayat/Van Panchayat/ State Forest Department (Social forestry wing)/ Van Vigyan Kendras (VVKs), sacred groves,. Group discussion at farm homesteads. Preparing individual and village level production plans. Preparation of charts, posters and flash cards. Participation in conducting exhibitions and method demonstrations/campaigns at the village level. Familiarization of the use of audio-visual aids. PRA exercises. Visit to village to study the community forestry components- Community reserve, organizational set up and administrative procedures in a social forestry (SF) Range, Microplan preparation-Field visit to a JFM operational area and conduct PRA surveys. Afforestation techniques and social forestry.

Suggested reading:

FAO (1984). Forestry extension, making it work, An international journal of forestry and forest industries, Unasylva - No. 143, Published by FAO.

L.K. Jha and P. K. Sen Sarma, A.P.H. (2008). A Manual of Forestry Extension Education, Published by VEDAMS, P. 386 p.

D. Sim, H. A. Hilmi (1987), Forestry Extension Methods, FAO Forestry Paper-80, P. 153.

Jalihal, K.A. Veerabhadraiah, V. (2007), Fundamentals of Extension Education and Management in Extension, Concept Publishing Company.

Balakathiresan, S. (1986). Essentials of forest management, Nataraj Publishers, Dehradun.

Bullock, R. C. L. and Hanna, K.S. (2012). Community Forestry Local Values, Conflict and Forest Governance. Cambridge University Press.

Gunter, J. (Ed.). (1973). The Community Forestry Guidebook (http://www.forrex.org/ sites/ default/ files/ forrex_series/FS15.pdf).

Ojha, H.R., Timsina, N.P., Kumar, C., Banjade, M.R and Belcher, B. (2007). Communities, Forests and Governance: Policy and Institutional Innovations from Nepal. Adroit Publishers, New Delhi, India.

Roy, S.B. and Chatterjee, M.(1994). Joint Forest Management. Inter India Publications

Tiwari, K.M. (1983). Social forestry for rural development. International Book Distributors.

Vyas, G. P.D. (2006). Community Forestry. Agrobios, India

SAF-321 Plantation Forestry 3 (2+1)

Theory

Plantations-definition and scope. History of plantations, Development of plantation forestry, Plantation organization and structure, Land and plantation development. Plantation planning-National and regional planning-project appraisal and project implementation– feasibility studies. Plantation silviculture - Choice of species- Plantation establishment- Plantation maintenance-Nutrition in plantations- use of fertilizers- Major pest and disease in plantations- sanitation and control measures. Dynamics of stand growth- CCF-MCA- stand density management in plantations- Thinning regimes- improvement-felling, Site quality evaluation, stand basal area-site index concept in plantation forestry- plantation productivity assessment- growing stock

assessment- MAI, sustainability of plantations. Plantation records- plantation journal. Industrial plantations- paper and pulp wood- match wood, plywood plantations- Plantations yielding NTFPs- Energy plantation- high density short rotation plantations- petro crops- avenue plantations- Plantations as potential carbon sinks carbon sinks- Economic factors in plantation development- social and cultural considerations**.** Monitoring and evaluation of Plantations.

Practical

Study the tools and materials for plantation establishment- Visit small and large plantations- study their management and functioning. Study the planting density and stand management regimes for various end uses such as timber, pulpwood, plywood, cottage industries etc. Exposure to plantation project preparation- economic evaluation and feasibility studies of plantation projects. Study of planting operations- study of tending techniques- Planting methods and techniques for different types of plantations including energy plantations, canal bank plantations - pulp wood plantations- study of Forest Development Corporation plantations-road side plantations plantation planning- Plantation journal- Choice of species for plantations- economic considerations in plantation- Study of Govt vs. pvt. Plantations.

Suggested reading

Bowen, G.D., E. K. S. Nambiar, E.K.S 1984. Nutrition on Plantation Forests. Academic Press, 1984 -Nature - 516 pages

Evans, J. 1992. Plantation Forestry in the Tropics, 2nd edition. Oxford, UK, Clarendon Press.

Evans, J. and Turnbull, J.W. 2004. Plantation Forestry in the Tropics: The Role, Silviculture and Use of Planted Forests for Industrial, Social, Environmental and Agroforestry Purposes. OUP Oxford, 467p.

Krishnapillay.B. 2000. Silviculture and Management of teak plantations. Unasylva. 201. Vol 51. 14-21p

Nambiar, E.K.S. and Brown, A.G. 1997. Management of Soil, Nutrients and Water in Tropical Plantation Forests. Australian Centre for Internat. Agricultural Research. 571p.

Nambiar, E.K.S., Cossalter, C and Tiarks.A. 1998. Site Management and Productivity in Tropical Plantation Forests. Workshop Proceedings, South Africa.

Suzuki, K., Ishii, K., Sakurai, S. and Sasaki, S. 2006. Plantation Forestry in the Tropics. Springer Tokyo

SAF-322 Recreation & Urban Forestry 2(1+1)

Theory

Forest recreation – Definition and scope – social and environmental aspects of recreation components new approaches in forest recreation. Principles and elements of landscaping -types of landscape designs formal-Persian and Mughal designs, and informal- British and Japanese. Landscape components- plant and other components- lawn, pergolas, hedges, edges, topiary, baloon, arbours, carpet beds, trees, flower beds, annuals, and climbers. Practices of landscaping- Tools and implements for landscaping. Specialised gardens-butterfly, water, bog or marsh, terrace, roof, Sunken, Indoor and rock. Planning and planting programmes in institutional and

industrial complexes, roads, bridges, parking area and other structures. Urban forestry – definition and scope – uses of urban forests, Management of urban forest-Arboriculture and its importance in urban forestry. Nature park, nature trial, Biological park, Ecopark, BD park , Ecotourism, Signages Restoration and rehabilitation of natural landscapes in India.

Practical

Preparation, planning and designing the planting pattern for parks, sanctuaries and industrial complexes – familiarise with the components of landscaping – studies on the features of flowering and foliage trees suitable for avenue planting – visit to landscaped areas, parks tourist spots and centres, national parks and sanctuaries., practice, planting methods.

Suggested reading

Douglar, J. Hort, R. A and Ranganadhan, S. (1982). Forest Farming. Natraj Publications, Dehradun.

Gopikumar K. (2008). Arboriculture Principles and Practices. Published by Khanna Bandhu, Dehradun

Hamm, W.E and Cale, D.N.(1987). Wild Land Recreation, John Wiley and Sons, New York .

Miller, R.W.(1988). Urban Forestry. Prentice Hall International Ltd. London

Singh, S.P. (1986). Planting of Trees. B.R. Publishing Corporation, Delhi.

Urban Forestry and Urban Greening. An International Journal aimed at presenting high-quality research with urban and peri-urban woody and non-woody vegetation and its use, planning, design, Elsevier Publications.

SAF-411 Forest Inventory and Yield Prediction 2 (1+1)

Theory

Yield - In regular forests-In Irregular forests. Estimation of growth and Yield of stands - Forest Inventory - Point sampling Forest Inventory - Definition-objectives- Kinds of enumeration- Tree assessment techniques- Measurement of wood volume, tree volume & tree volume tables - Kinds of sampling -Sampling design - Kinds of sampling units- Fixed area and point sampling units - Plots, strips, topographical units - sampling intensity- Inventory designs used in India - Sampling errors and non sampling errors.- Organisation of field work and conduct of enumeration - Point sampling- Concept of horizontal point sampling . Estimation of growth and yield prediction in forest stands- Stand structure - Growth of stand - Methods of predicting future growth of stands - Stand density - Canopy density -Crown competition factor- Yield tables- definition- Preparation of yield table - Application and use of yield tables - Stand table-definition and use.

Practical

Study the demarcation and alignment of plots, strips etc. Field exercise on Horizontal Field demonstration of various sampling techniques- Simple, stratified, multi stage, multiphase, non-random sampling techniques. Visit forest areas for forest enumerations- point sampling- use of wedge prism and Relaskop - Field exercise on the determination of site quality -Visit to local

forest divisions and study the methods of preparation and use of yield tables. Method demonstration on the use of aerial photographs in forest inventory.

Suggested Readings

Chapman, H.H and Meyer, W.H. (2008).Manual of Forest Mensuration: Methods and Techniques. Asiatic Publishing House, New Delhi, 522p.

Chaturvedi, A.N and L.S. Khanna. (2011). Forest Mensuration and Biometry (5th edition). Khanna Bandhu. Dehra Dun. 364 pp.

Heindjik, D. (1975). Forest Assessment. International Book Distributors, Dehradun, 349p

Husch, B., Beers, T.W. and Kershaw,Jr. J.A.(2002). Forest Mensuration (4th edition). John Wiley & Sons, Nature.456 pp.

Kangas, A. and Maltamo, M. (2006). Forest Inventory: Methodology and Applications. Managing Forest Ecosystems (Vol.10).Springer.340pp.

Philip, M.S.(1994).Measuring Trees and Forest. AB International, UK,310p

Scott,C.T and Gove, J.H. (2002). Forest Inventory. Encyclopedia of Environmetrics (Vol 2), John Wiley & Sons. pp 814–820

Shiver, B.D and Borders, B.E.(1996). Sampling Techniques for Forest Resource Inventory. John Wiley and Sons, New York, 356p

Spurr, H.S.(1952).Forest Inventory. John Wiley and Sons, New York, 476p.

SAF-412 Agroforestry Systems and Management 3(2+1)

Theory

Land use and land capability classification- overview of agroforestry around the world – agroforestry systems in India. Classification of agroforestry systems – structural, functional, agro-ecological, socio-economic and physiognomic basis. Agrosilvicultural systems – Improved fallows in shifting cultivation – soil dynamics in shifting cultivation – Taungya systems – Alley cropping –structural and functional attributes. Multipurpose trees and shrubs on farmlands, agricultural fields- Plantation crop combinations- commercial crops under shade of planted trees and natural forests- Windbreaks & Shelterbelts. Silvopastoral systems – protein banks, Live fence of fodder trees and hedges, trees and shrubs in pastures. Pastoral silviculture systems-grassland and tree management in the humid, arid and semi- arid regions. Agro-silvopastoral systems – tropical home gardens – structural and functional attributes. Other systems – apiculture, sericulture and mixed woodlots. Major Agroforestry practices in different agroecological zones of India- arid and semi arid regions- agroforestry practices for wasteland reclamation. Agroforestry practices for salt affected soils – Agroforestry practices for wetlands and waterlogged areas. Non-wood forest products based agroforestry – Soil fertility improvement and water conservation through agroforestry. Aboveground and belowground interactions- Manipulation of density, space, crown and roots. Tree Management – structure and growth of trees, crown and root architecture, agro-forestry practices to minimize negative interaction – coppicing, thinning, pollarding and pruning – crop planning and management – selection of suitable crops –management of nutrients, water and weeds – Socio-economic

analysis of various agroforestry systems. Diagnosis and design methodology, National Agroforestry Policy 2014,Green highways-2015—National and International organizations in Agroforestry. Climate change risk on farming and forests, Evergreen farming.

Practical

Study the desirable characteristics of trees/shrubs/grasses for various agroforestry programmes. Assessment of standing stock of tree species in various agroforestry systems such as homegardens. Survey of agroforestry practices in local/adjoining areas. Field observations to characterize the structural, functional and economic attributes of the following agroforestry systems and practices- agrosilviculture systems, silvopastoral systems, pastoral silviculture systems, agrosilvopastoral systems, shelterbelts and windbreaks, live fences; fodder trees and protein banks. Exercise on Diagnosis and Design of agroforestry systems and practices. Assessment of productivity of tree crop combinations. Studying resource partitioning in agroforestry systems - water, light and nutrients. Analysis of soil and plant samples for organic carbon N, P and K.

Suggested reading

Huxley, PA 1983 (ed). *Plant Research and Agroforestry*, ICRAF, Nairobi, Kenya.

Huxley, P. 1999. Tropical Agroforestry. Wiley: 384p.

Kumar, B. and Nair, P.K.R. (eds). 2006. *Tropical Homegardens*: A Time-Tested Example of Sustainable Agroforestry. Volume 3 in the Book Series "Advances in Agroforestry". Springer Science, the Netherlands

Kumar, B.M. 2011. Species richness and aboveground carbon stocks in the homegardens of central Kerala, India. Agriculture, Ecosystems and Environment. 140: 430–440

Kumar, B.M. and Nair, P.K.R. 2004. The enigma of tropical homegardens. 2004. Agroforestry Systems. 61: 135–152.

Kumar, B.M. and Nair, P.K.R (eds). 2011. Carbon Sequestration Potential of Agroforestry Systems: Opportunities and challenges. Advances in Agroforestry 8. Springer Science, The Netherlands: 307p

Michael P. 1984. *Ecological Methods for Field and Laboratory Investigations*. Tata McGraw-Hill Pub. Co. New Delhi.

Mohan, S., Nair, P.K.R., Long, A.J. 2007. An Assessment of Ecological Diversity in Homegardens: A Case Study from Kerala State, India. Journal of Sustainable Agriculture. Volume 29, Issue 4: 135-153.

Nair, P.K.R, Rao MR, and Buck LE (eds), 2004. *New Vistas in Agroforestry*: A Compendium for the 1st World Congress of Agroforestry, Kluwer, Dordrecht, The Netherlands.

Nair, PKR 1993. *An Introduction to Agroforestry*. Kluwer Academic Publishers, Dordrecht, The Netherlands.

Nair, P.K.R. Agroforestry Systems in the Tropics. Springer. 680p.

Nair, P.K.R., Kumar, B.M. and Vimala D. N. 2009. Agroforestry as a strategy for carbon sequestration. J. Plant Nutr. Soil Sci. 172: 10–23.

Pathak P.S. and Ram Newaj (eds.) 2003. *Agroforestry: Potentials and Opportunities*. Agrobios, Jodhpur.

FPU-121 Wood Anatomy 3 (2 + 1)

Theory

Introduction to wood anatomy. Classification of plant kingdom. Gymnosperms versus angiosperms. Kinds of woody plants. The plant body; a tree and its various parts. Meristems; promeristem, primary meristem, secondary meristem. Simple tissues; parenchyma, collenchyma, sclerenchyma and the vascular tissues. Parts of the primary body; typical stems and roots of dicots and monocots. Secondary growth in woody plants. Mechanism of wood formation in general, and with special reference to typical dicot stem. Ray initials and fusiform initials; anticlinal and periclinal division. Physiological significance of wood formation. The macroscopic features of wood, sapwood, heartwood, pith, early wood, late wood, growth rings, wood rays, etc. Sapwood versus heart wood, anatomical differences. Transformation of sapwood to heartwood; factors affecting transformation. Microscopic features of wood. Prosenchymatous elements, tracheids, vessels, fibers. Parenchymatous elements, parenchyma and rays, resin canals, gum canals, latex canals, infiltrants in wood. Three dimensional features of wood; transverse, tangential and radial surfaces. Elements of wood cell walls. The structure and arrangement of simple pit, bordered pits. Extractives in wood. Comparative anatomy of gymnosperms and angiosperms. Anatomical features of common Indian timbers; classification into porous and non-porous woods, ring porous and diffuse porous woods. Effect of growth rate on wood properties. Juvenile wood and mature wood.

Practical

Study of primary growth in stems of typical dicots and monocots. Study of wood formation in typical dicot stem. Study of vascular bundles in monocots. Parts of the logs (woody trunks), and the three distinctive surfaces of wood (i.e. cross, radial and tangential planes). Timber identification and its importance. Procedures for field identification of timbers. Study of physical features of wood. Study of gross features of wood. Study of anatomical features of wood, pores or vessels, different types. Study of soft tissue in timbers and their different types distributions. Study of wood rays, and their different types. Study of the non-porous woods, their physical and anatomical description. Study of infiltration and inclusions in wood. Anatomical keys and methods to use them. Dichotomous keys, punched card keys and computer aided identification. Field identification of important timbers of Rajasthan.

Suggested reading

Hoadley, B. 2000. Identifying wood-Accurate results with simple tools. Taunton Press,Newtown, USA. 223p.

Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.

Rao, R. K. and Juneja, K. B. S. 1992. Field identification of fifty important timbers of India. Indian Council of Forestry Research and Education, New Forest, Dehra Dun. 123p.

FPU-221 Wood Products and Utilization 3 (2+1)

Theory

Uses of wood. Growth of wood based industry in India, effect of globalization. Importance of forest based industries in relation to Indian economy. Wood as a source of energy and chemicals, wood as raw material for industries like pulp, paper, rayon, composite woods and improved woods. Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of wood of lesser known forest species for commercial purposes. Structural uses of Timber – bridges and other super structures. Decorative uses of wood. Introduction to wood modification, its need and scope, chemical modification of wood (acetylation, reaction with isocyanates, acetates, ethers, epoxides etc.). Primary conversion; sawing and veneering. Composite wood; plywood, laminated wood, core board, sandwich board, fibre board, particle board; manufacturing process, uses and properties. Adhesives used in manufacture of composite wood. Improved wood; compressed wood, impregnated wood etc.; manufacturing process, uses and properties. Nano technology in wood. Manufacture of rayon and match. Wood carving and handicrafts. Destructive distillation of wood. Saccharification of wood. Production of wood molasses, alcohol and yeast. Biochar technology, bioenergy concepts - short rotation crops as raw materials.

Practical

Estimation of specific gravity and calorific value of wood specimens. Maceration techniques and determination of sizes of fibres, vessels etc. Visits to various wood based industries like, plywood, packing case, match, tannins, furniture, saw mills etc. to study the manufacturing process. Visit to saw mill to study veneering and different kinds of sawing. Handicraft manufacturing unit. Visit to wood distillation unit. Visit to nearby industrial plantations.

Suggested reading

Baldwin, R. F. 1981. Plywood manufacturing practices. Revised 2nd Ed. Miller and Freeman Publication, Inc. USA. 388p.

FRI [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.

Hoadley, B. 2000. Understanding Wood: A Craftsman's guide to wood technology. Taunton Press. Newtown, USA. 223p.

FPU-222 Ethnobotany and Medicinal & Aromatic Plants 3 (2+1)

Theory

Definition and scope of ethnobotany. Terms employed in relation to ethnobotany and its relationship with man and domestic animals. Ethnic – people and their contribution in therapeutic and ethnobotanical knowledge especially with respect to medicinal and allied aspects. Important plants and their folk uses for medicines, food, dyes, tans, etc Methods and tools in Ethnobotanical studies. Ethnobotany of tribals in India. Traditional Botanical Knowledge- concepts. Ethnobotany of the plants from the following families. Guttiferae (Clusiaceae), Malvaceae, Fabaceae, Mimosaceae, Caesalpinaceae, Combretaceae, Umbelliferae (Apiaceae), Rubiaceae, Asteraceae, Ebenaceae, Apocynaceae, Asclepiadaceae, Euphorbiaceae, Lauraceae, Palmaceae, Poaceae, Liliaceae, Coniferae, Santalaceae, Thymeliaceae.

Definition - role of medicinal and aromatic plants in Indian economy - Important essential oil yielding plants in India - Detailed study of lemon grass, citronella, palmarosa, vetiver, japanese mint, eucalyptus, jasmine, patchouli and geranium - botany, climate and soil requirements, planting cultural and manorial practices - harvesting, curing and extraction of essential oils. Medicinal plants in India and Rajasthan - history, origin, area and distribution, production, botany and varieties - cultivation, extraction of active principles and their uses - uses of different medicinal plants like *Atropa, Cinchona, Rauvolfia, Opium, Sandal, Acorus, Withania somnifera, Plantago ovata, Cassia angustifolia and Aloe barbedensis ,* Akarkara, Guggal, Safed musli ,Periwinkle*, Neem, Dioscorea, Costus, Solanum* etc. Cultivation practices of medicinal plants like *Adhathoda zylanica*, *Sida cordifolia, Sterospermum colais*, *Plumbago zeylanica*, *Tinospora cordifolia*, *Indigofera tinctoria.* Conservation packages for the medicinal plants collected in wild.

Practical

Field visit to different tribal regions to gain ethnobotanical knowledge and the inter-relation between plant and people- Survey and identification of plants used by the tribals for medicine, food and other social purposes- Collection and preparation of herbarium specimens of the above plants- Identification of medicinal and aromatic plants – propagation techniques – Harvesting and oil extraction of aromatic plants – Field visit, collection and preparation of herbarium – Visiting commercial units of medicinal plants.

Suggested reading:

Atul, C.K. and Kapur, B.K. (1982). Cultivation and utilization of medicinal plants. RRL., CSIR, Jammu-Tawi.

Chopra, R.N., Nayar, S.L. and Chopra, I.C. (1956). Glossary of Indian medicinal plants. CSIR, New Delhi.

Cunningham, A. 2014. Applied Ethnobotany: "People, Wild Plant Use and Conservation". Taylor & Francis,

EIRI Board. (2007). Handbook of Medicinal and Aromatic Plants: Cultivation, Utilisation and Extraction

Ethnobotany. Principles and applications. (1997). C. M. Cotton. John Wiley and Sons Ltd. 424p.

Gunther, E. (1975). The essential oils. Robert, K Krieger Pub. Co., New York.

Jain, S.K. 2010. Manual of Ethnobotany (2nd Ed). Scientific Publishers, India, 242p.

Maheshwari, J.K. 2000. Ethnobotany and medicinal plants of Indian subcontinent. Scientific Publishers, Jodhpur, India, 672p.

FPU-223 Forest Tribology & Anthropology 2 (2+0)

Theory

Meaning, scope and development of Anthropology. Relationships with other disciplines. Main branches of Anthropology, their scope and relevance. Human Evolution and emergence of Man. Phylogenetic status, characteristics and geographical distribution. Principles of Prehistoric Archaeology. Chronology: Relative and Absolute Dating methods. Culture, Society, Marriage,

Family, Kinship, Economic and Political Organization, Social Control, Religion, Anthropological theories, Language and Communication, Research Methods in Anthropology. Race and Racism. Applications of Anthropology. Ethno-archaeology in India. Demographic profile of India. The structure and nature of traditional Indian social system. Caste system in India Definition and characteristics of a tribe. Tribes and aborigines- an anthropological perspective. Racial classification and distribution of tribes. Tribes in India and Kerala. Tribal economy. Tribals and Constitution of India Administration of tribal areas in independent India- appraisal of tribal development - problems of tribal identity and integration in the mainstream. Relation between tribes and forests- forest as their immediate environment. Forests as the means of livelihood. Girijan habitat - changes consequent to government control of forests. Forest management and tribal welfare- management conflicts and way forward. Role of forest department in tribal welfare. Role of Non wood Forest products in the economy of tribal's and Tribal cooperative societies. Social forestry and tribal welfare.

Suggested reading:

Furer-Haimendorf, C.V. 1985. Tribes of India - the struggle for survival. OUP. New Delhi

Hasnain, N. 2007. Tribal India. New Royal Book Company

Hasnain, N. 2011. Indian Anthropology. Palaka Prakashan

Sharma, R.N. and Bakshi, S. 1984. Tribes and tribal development. Uppal Publ. House, New Delhi

Sharma, R. N., Sharma, R.K. 1997. Anthropology. Atlantic Publishers & Distributors.

Thakur, D. 1986. Socio-economic development of tribes in India. Deep and Deep Publications, New Delhi

FPU-311 Wood Science & Technology 3 (2+1)

Theory

Kinds of woods; hardwood, softwood, bamboos and palms, merits and demerits of wood as a raw material, the physical features of wood. Electrical, thermal and acoustic properties of wood. Mechanical properties of wood like tension, compression, bending, shearing, cleavage, hardness, impact resistance, nail and screw holding capacities. Suitability of wood for various uses based on mechanical and physical properties. Wood water relationship; shrinkage, swelling, movement, fibre saturation, equilibrium moisture content. Wood seasoning; merits, principles and types; air seasoning, kiln seasoning and chemical seasoning. Refractory classes of timbers, kiln schedules. Seasoning defects and their control. Classification of timbers based on durability. Wood preservation; principles, processes, need, types of wood preservatives (Water soluble, oil based, etc.). General idea about fire retardants and their usage. Non-pressure methods; steeping, dipping, soaking open tank process, Boucherie process. Pressure methods; full cell process, empty cell process (Lowry and Rueping). Wood machining. Sawing; techniques, kinds of saws; cross cut, edging, cudless, hand, circular and bow saws. Wood working, tools used in wood working (parting, slicing, shaping, measuring and marking tools). Various stages in wood

working. Dimensional stabilization of wood by surface coating method, bulking method, impregnation of resins and polymers.

Practical

Mechanical tests on timber. Static bending, impact bending, compression parallel and perpendicular to the grain, hardness, shear, torsion, nail and screw pulling test, brittleness test and calculation of properties.Estimation of combustibility of wood using bomb calorimeter. Estimation of directional shrinkage and swelling of wood. Familiarization of non-destructive wood testing instruments. Visit to wood testing laboratories.

Suggested reading

Bowyer J. L., Shmulsky, R. and Haygreen, J. G. 2007. Forest products and wood science: An introduction. 5th Ed. Blackwell publishing, Ames, IA. 496p.

Brown, H. P. 1985. Manual of Indian wood technology. International books and periodicals supply service, New Delhi. 121 p.

FRI. [Forest Research Institute]. 1976. Indian forest utilization. Volume I and II. Forest Research Institute, Dehradun. 941p.

Panshin, A. J. and De Zeeuw, C. 1980. Textbook of wood technology, 4th Ed. McGraw-Hill. New York, USA: 722p.

USDA [U.S. Department of Agriculture]. Wood handbook - Wood as an engineered material. 1999. U.S. Department of Agriculture, Forest Service. Forest Products Laboratory, Madison, WI. 508p.

FPU-312 Tree Harvesting and Ergonomics 2 (1+1)

Theory

Definition and scope of logging, logging plan and execution. Location and demarcation of the area for logging and estimation of produce available for extraction. Implements used in logging operation; traditional and improved tools. Felling rules and methods, Work contracts related to felling and removing (contract system, convener systems) etc. Conversion, measurement and description of converted material. Means of transport of timber; carts, dragging, skidding, overhead transport, ropeways, skylines. Transport by road and railways. Transport by water; floating, rafting and concept of booms. Non-destructive sampling methods of wood. Grading and storage of timber in the depots for display and disposal, temporary and final storage. Timber Depots; types, lay out and management. Systems of disposal of timber. Ergonomics: definition, components and provision of energy. Requirement of energy and rest periods. Effect of heavy work, posture, weather and nutrition. Personal protective equipments, safety helmets, ear and eye protections. Accidents: causes, statistics, safety rules and first aids.

Practical

Equipments and tools used in logging operations and their uses. Instructions regarding maintenance of various records and registers in logging operations; Conversion of felled trees into logs, poles, firewood, pulpwood. Visit to local saw mills to study the equipments used and

process of conversion. Measurement of logs, poles and firewood in forests and maintenance of records in relevant registers. Visit to local dumping yard (timber depot) to trace the logs delivered from different forest sites. Sorting of logs, poles and firewood in the depots according to species, quality, length and girth classes. Stacking and stock checking of different logs, poles and firewood in the depots so as to confirm that all the converted materials in the forests have reached their destination. Stacking of the lots for display and final disposal; recording of the lots for auction sale. Final disposal of the material. Visit during the auction sale in the government timber depots; Preparation of ergonomic check lists. Familiarize the e-auctioning procedure of State Forest Department. Safety rules and first aids in forestry operations

Suggested Reading

Brown, N. C. 2002. Principles and methods of harvesting of timber. Biotech books, Delhi. 430p.

Staaf, K.A.G. and Wiksten, N.A. (1984). Tree Harvesting Techniques. Martinus Nijhoff/DR W. Junk Publishers, Netherlands.

FRI. [Forest Research Institute]. 1976. Indian forest utilization.Volume I and II. Forest Research Institute and colleges, Dehradun. 941p.

GFC. [Guyana Forestry Commission]. 2002. Code of practice for timber harvest. 2nd Ed. Georgetown, Guayana. 42p.

Hakkila, P. 1989. Utilization of residual forest biomass. Springer-verlag, Berlin. 567p.

Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.

Jones, J. T. 1993. A guide to logging aesthetics. Northeast Regional Agricultural Engineering Service, Ithaca, New York. 36p.

Mehta, T. 1981. A handbook of forest utilization. IBD Dehradun. 298p.

Wakermann, A. E. 2002. Harvesting timber crops. Biotech books, Delhi. 433p.

FPU-321 Non-Timber Forest Products 3(2 +1)

THEORY:

Introduction, methods of collection, management and importance of Non-Wood Forest Products (NWFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non Essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees. Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits and vegetables, spices, poisons and bio-pesticides. Honey, Lac, and silk- their importance, extent and processing.

PRACTICAL:

Visit to nearby forests to study important NTFP yielding plants. Study of fodder: grasses and tree leaves. Study of canes and bamboos and their sources. Study of essential oils and their sources. Study of non-essential oils and their sources. Study of gums and resins and their collection. Study of tans and dyes and their sources. Study of fibers, flosses and their collection from nearby forests. Visit to Herbal Gardens and herbaria to study medicinal plants. Study of plants yielding drugs, spices, wild fruits, poisons and bio-pesticides and their collection from nearby forests. Visit to nearby extraction units.

SUGGESTED READINGS:

Anon, (1998) Wealth of India, Raw Material, Vol. I-IX, CSIR, New Delhi

Anon (1986) The Useful Plants of India, CSIR, New Delhi

Maheswari, p. and Sigh, U. (1981) Dictionary of Economic plants of India. ICAR, New Delhi

Yongken, H.w. (2003) Natural Drugs. Biotech, New Delhi.

Manmohan, J.R. *et al*. (2007) Manual of Manual of Non-Wood Forest Products. CH & F, Jhalawar

Kirshnamurty, T. (1993) Minor Forest Products. Oxford and IBH Pub House, New Delhi

O.P. Sharam(1984) Extraction Technology of Katha and kutch manufacturing. IBD, Dehradun

Dewedi, A.P. (2007) Forests- Non Wood forest Resources. IBD, Dehradun

FPU-322 Marketing and Certification of Forest Products 3 (2 +1)

Theory

Types of markets for timber and non-timber forest produce, market locations of timber and non-timber forest produce and their features. Demand forecasts. Price determination in timber and non-timber forest produce. Economic features of specialized timber markets in terms of degree and type of competition in buying and selling, price spread, costs of marketing functions involved like pre-commercial thinning, commercial thinning, harvesting, hauling, sawing, transportation, treatment of wood, carpentry, and other processing activities involved in teakwood, rosewood, matchwood, pulpwood, sandalwood, veneers; type and degree of competition in market for services of saw mill and other intermediate wood processing industries, price spreads across different channels of marketing. Economic features of specialized markets in terms of degree and type of competition for bamboo, canes, lac, gums, resins, hides and skins. Economics of gathering medicinal plants from forests, economics of processing medicinal plants. Domestic demand and trade in timber and non-timber forest products. International demand and trade in timber and non-timber forest produce. Market inefficiencies in timber, non-timber forest produce and measures to check in efficiencies, role of cooperative societies in marketing of timber and non-timber forest produce. Economic policy and regulations of international timber trade. Essentials of World Trade Organization, GATT, Dunkel proposals, Intellectual Property Rights and Patenting. International Timber Trade Organization (ITTO) and timber certification. Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Programme for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

Practical

Library review of studies on marketing and trade of timber; forest produce (teak, rosewood, *Terminalia* spp. *Pterocarpus* and other important timber of national importance etc.); Non-Timber Forest Produce (NTFP such as bamboo, canes, eucalypts etc.); forest based medicinal plants. Visits to timber produce and NTFP markets to collect price data and quantity sold and to observe auctions and competitions. Analysis of price and quantitative data of timber forest produce, NTFP for examining trend; seasonal, cyclical variations. Visit to markets of forest based medicinal plants. Study of buy back arrangements in forest based medicinal plants trade. Valuation of timber and NTFP (existence value, use and option values, intrinsic value etc). Development of hypotheses to study the marketing of forest produce. Presentation of results on analysis of price and quantity. Economics of processing pulp to paper/poly fiber;wood to plywood/veneers.

Suggested reading

Gray, J. W. 1993. Forest resource systems in developing countries. Food and agricultural organization. Rome. 259p.

ITTO. [International Tropical Timber Organisation]. 1993. The economic linkages between international trade in tropical timber and sustainable management of tropical forests. London environmental economic centre, International Institute for Environment and Development, London, UK. 330p.

ITTO. [International Tropical Timber Organisation]. 2012. Annual review and assessment of the world timber situation, Yogyakarta, Indonesia. 182p.

Kula, E. 1996. The economics of forestry: Modern theory and practice. Timber press, Portland, Oregon. 182p.

Muraleedharan, P. K. Subramanian, K. K., and Pillai, P. P. 1998. Basic readings in forest economics. Kerala Forest Research Institute and Ford Foundation, Thrissur, Kerala. 177p

Tewari, D. N. 1995. Marketing and trade of forest produce; International Book Distributors (Book Sellers & Publishers), Dehradun, India. 140p.

Bass, S. Introducing forest certification. 1996. A report prepared by the Forest Certification Advisory Group (FCAG) for DGVII of the European Commission. European Forest Institute, Discussion Paper 1. 30p. Details available at: http://www.giz.de/Themen/de/dokumente/en-d28-inenpenennt-certification-verification-forest-manage.pdf

Bass, S., Thornber, K., Markopoulos, M., Roberts, S. and Grieg-gran, M. 2001. Certification's Impact on forests, stakeholders and supply changes. International Institute for Environment and Development. London. 153p.

Conroy, M. E. 2007. Branded! How the "certification revolution" is transforming global corporations. New Society publishers, Gabriola Island, BC. 354p.

Gupta, H. S., Yadav, M., Sharma, D. K. and Singh, A. M. 2013. Ensuring sustainability in forestry: certification of forests. TERI, New Delhi. 284p.

FPU-322 Certification of Forest Products 2 (2 +0)

Theory

Definition of forest certification. Responsible sourcing of wood. Principal stages in the process of certification. Producer's motivation for supplying certified forest products. Key aspects of certification. Principles of sustainable forest management. Origin of certification. Organizations responsible. Legislations and policies of importance. Certification schemes in operation. Forest Stewardship Council (FSC), Programme for Endorsement of Forest Certification Schemes (PEFC) etc. CIFOR certification tool kit. Organic certification of MFPs, Forest resources and forestry practices in different regions of the world - Western Europe, North America, Central Africa, Australia, Central America, Russia, Japan, and China. General problems of forest development and economy.

Indian scenario in certification. International trade in tropical logs and sawn wood. Pros and cons of certification. Potential for certifying forests and forest products of India. Tracing illegal logging. Identification of species and region of origin. Timber tracing through genetic methods and (analysis of stable isotope ratios).

FBT-111 Dendrology 3(2+1)

Theory

Introduction – importance and scope of dendrology, Principles and systems of plant classification systems. Detailed study of Bentham and Hooker natural system, its advantages and disadvantages. Plant Nomenclature –objectives, principles and International Code o f Botanical Nomenclature. Role of vegetative morphology in identification of woody forest flora. Peculiarities of bole, general form of woody trunk and deviations like buttresses, flutes, etc. Morphology and description of barks of common trees.

Characteristics of blaze, bark colour, exudations etc. Morphology of leaf, different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts.

Detailed study of the families- diagnose the features-floral variations–distribution and economic importance- systematic position as per Bentham & Hooker System of classification- Magnoliaceae, Annonaceae, Guttiferae, Dipterocarpaceae, Malvaceae, Sterculiaceae, Tiliaceae, Rutaceae, Meliaceae, Sapindaceae, Anacardiaceae, Combretaceae, Myrtaceae, Rubiaceae, Sapotaceae, Apocyanaceae, Bignoniaceae, Lamiaceae, Lauraceae, Euphorbiaceae, and Graminae. Brief study of the families-Bombacaceae, Santalaceae, Casuarinaceae, Orchidaceae, Palmae Rhizophoraceae Pinaceae Fabaceae and Mimosaceae.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. General study of herbarium. Dis-section of flowers-making sketches-construction of floral diagrams of one species of the following families: Annonaceae

and Guttiferae, Dipterocarpaceae and Malvaceae, Sterculiaceae and Tiliaceae, Rutaceae and Meliaceae, Sapindaceae and Anacardiaceae, Fabaceae (Papilionaceae) Mimosaceae Caesalpiniaceae, Combretaceae, Myrtaceae, Rubiaceae, Sapotaceae, Apocyanaceae and Bignoniaceae, Lamiaceae, Euphorbiaceae, Santalaceae and Casuarinaceae, Graminae and Meliaceae.

Suggested reading

Ashok Kumar (2001). *Botany in Forestry and Environment*. Kumar Media (P) Ltd. Gandhinagar, Gujarat.

Bor N. L. (1990). *Manual of Indian Forest Botany*. Periodical Expert Book Agency. New Delhi.

Brandis. D. Revised by R. D. Jakarti (2010). *Indian Trees.* Dehradun.

Charles McCann. (1966). *100 Beautiful Trees of India*. D. B. Taraporevala Sons & C. Pvt. Ltd. Mumbai. (Available online PDF)

Eric A. Bourdo Jr. (2001). *The Illustrated Books of Trees. A Visual Guide to 250 species.* Published by Salamander Books Pvt. Ltd. London. (Available online PDF)

Father H. Santapau. (1966). *Common Trees*. (Available online PDF)

Gurucharan Singh. (2000). *Plant Systematics*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

Hardin, W., Harrar, E.S., and White, F.M. (1995) Textbook of Dendrology (8th Edition). McGraw-Hill Companies, London

Jain S. K. and R. R. Rao. (1977). *Handbook of Field and Herbarium Methods*. Today and Tomorrow's Printers and Publishers. New Delhi.

Lawrence, G.H.M.(1967).Taxonomy of Vascular Plants. Oxford & IBH, NewDelhi.

Mishra. S. R. (2010). *Textbook of Dendrology*. Discovery Publishing House Pvt. Ltd. New Delhi.

Naqshi. R. (1993). *An Introduction to Botanical Nomenclature*. Scientific Publishers. Jodhpur.

Pandey S. N. and S. P. Mishra. (2008). *Taxonomy of Angiosperms*. Ane Books India, New Delhi.

Parker. R. N. (1933). *Forty Common Indian Trees and How to know them*. (Available online PDF)

Pradeep Kishan (2013). *Trees of Central India*. Published by Penguin Books India Pvt. Ltd. New Delhi.

Randhawa. M. S. (1957). *Flowering Trees in India*. Sree Saraswati Press Ltd. Kolkatta.

Rendle,A.B.(1979). Classification of flowering plants. Vol.I&II CUP–VIKAS

Sahni. K. C. (2000). *The Book of Indian Trees*. Bombay Natural History Society. Mumbai.

Tewari D. N. (1992). *Tropical Forestry in India*. International Book Distributors, Dehradun.

FBT-112 Plant Cytology and Genetics 2 (1+1)

Theory

History of genetics. Mendel's principles of inheritance – segregation – independent assortment. Cell – structure and functions. Cell organelles. Cell reproduction – mitosis – meiosis and its significance. Chromosome theory of inheritance. Modification to Mendelian inheritance – multiple alleles – codominance – gene interaction – epistasis –pleotrophy – polygenic inheritance – penetrance and expressivity – cytoplasmic inheritance. Linkage and crossing over – cytological consequence of crossing over. Detection of linkage and linkage maps. Chromosomal aberrations-

numerical and structural. Structure of DNA and types and its replication. Chromosomes – its structure and function. Fine structure of gene; Gene expression and their functions. RNA its structure function and types. Gene action – protein synthesis. Mutation, its classification and uses.

Practical

Study of fixatives and stains. Preparation of slides showing various stages of mitosis. Preparation of slides showing various stages of meiosis. Working out problems related to monohybrid cross, dihybrid cross, independent assortment, linkage, gene mapping, probability and chi-square, multiple alleles etc.

Suggested reading:

Fletcher, H. and Hickey, I. (2012). Genetics. Garland Science,

Garner, E. J., Simmons, M. J. and Sunstad, P. D. (2008). Principles of Genetics (8th edn.). Wiley India (P.) Ltd., Daryaganj, New Delhi.

Gupta P. K. (1999). Cytogenetics Rastogi Publishers, Meerut

Strickberger, M.W. (1996). Genetics (3rd edn.). Mac Millan Publishing Co., New Delhi

Tamarin, R. (2002). Principles of Genetic (7th Ed). Tata McGraw-Hill Education.

White, T.L., Adams, W.T., and Neale, D.B. (2007). Forest Genetics. CABI

FBT-113 Plant Physiology 3 (2+1)

Theory

Introduction to tree physiology. Photosynthesis - C3, C4 and CAM plants - Photorespiration - Factors affecting photosynthesis. Respiration - energetics of dark respiration. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency. Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Forest Biomes. Light interactions models of forest canopies - Sun plants and shade plants - shade tolerance. Temperature - temperature influence on forest development - energy budgets - low and high temperature - Physiological adaptations for high temperature - chilling injury. Water stress - Mechanism of drought tolerance and drought resistances - Physiological basis of drought avoidance and tolerance. Water relations of forest trees – Transpiration from forest canopies – Evapotranspiration models of forest stands - Water use efficiency of forest stands. Salinity stress its effects on tree growth. Resistance to salinity. Forest and microclimate . Carbon balance and dry matter production in forest trees - Dry matter production and partitioning – source/ sink - . GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S.

Practical

Preparation of solutions. C3 and C4 leaf anatomy. Estimation of transpiration using porometer. Estimation of photosynthesis using IRGA. Extraction and estimation of chlorophyll in plants. Estimation of stomatal index. Demonstration of plasmolysis. Estimation of water potential in plants using Plant water status console. Estimation of leaf area of plants. Plant growth analysis –

RGR, NAR, and LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc… Measurement of moisture stress tolerance parameters in trees - membrane stability, chlorophyll stability, proline content, wax and cuticle thickness. Measurement of relative water content, leaf water potential, osmotic potential. Measurements of stomatal resistance/stomatal conductance under varying stress condition. Observation on tree architecture of important species

Suggested reading

Hopkins, W.G. and Huner, N.P.A. (2008) Introduction to plant physiology. Wiley.

Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York

Larcher, W. (2003). Physiological Plant Ecology: Ecophysiology and Stress Physiology of Functional Groups. Springer Science & Business Media

Lambert, Chapin, F.S. and Pons, T.L. (1998). Plant Physiological Ecology. Springer Scientific+ Business Media inc. Newyork.

Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London

Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Managment. Academic Press Inc., London.

Nobel P. S. (2005). Physicochemical and Environmental Plant Physiology. Elsevier Academic Press, Amsterdam

Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd. Singapore.

Taiz, L. and Zeiger, E. (2010) 5th edition Plant Physiology. Sinauer Associates, Inc., Massachusetts

FBT-211 Forest Ecology and Biodiversity 3 (2+1)

Theory

Historical development of ecology as a science. Levels of biological organization. Major forest Ecosystem. Forest environment- major abiotic and biotic components and their interaction, Nutrient cycling, trophic levels, food webs, ecological pyramids and energy flow. Population ecology - definition, population dynamics and carrying capacity, preparation of life table and its importance in forest management. Community ecology- species interactions, ecological succession- types, examples and its impact on flora and fauna, terminology, basic concepts, theories of succession- climax vegetation types, forest management and succession. Island Biogeography. Autecology of important tree species. Perturbation ecology- Biodiversity and conservation – definition, levels of study, distribution of diversity in life forms, hotspots of biodiversity, measurement of diversity and diversity indices. Principles of conservation biology. Endemism in relation to forest species, Wetland and Ramsar sites of India, Genetic and evolutionary principles in conservation. Biosphere concept. Conservation – efforts in India and worldwide.

Practical

Study of ecological modifications in plants; Effects of fire on forest ecosystem; Study of population dynamics using model systems; Preparation of life tables; Study of spatial dispersion among plants; Study of Forest composition; Niche analysis; Computation of diversity indices;

Measurement of diversity of plants and insects in a nearby forest; Study of succession in field and water bodies; Visit to different ecosystems.

Suggested reading

Odum EP 1983. Basic Ecology. Saunders College Publishing, Philadelphia etc. 613p

Misra KC 1974. Manual of Plant Ecology. Oxford &IBH Pub Co. New Delhi etc. 491p

Michael P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill Pub. Co. New Delhi, 404p

Montagnini, F and Jordan, C.F. 2005. Tropical Forest Ecology: The Basis for Conservation and Management. Springer. 295p.

Frankel, O.H., Brown, A.H.D., Burdon, J.J. 1995. The Conservation of Plant Biodiversity. Cambridge University Press. Cambridge. 299p

Sagwal, S.S. 1995. Forest Ecology of India. Pioneer Publishers, India. 368p

FBT-212 Tree Improvement 3 (2+1)

Theory

Introduction – history and development of tree improvement – its relation to other disciplines of forestry. Reproduction in forest trees. Anthesis and pollination – their importance in tree breeding. Incompatibility and sterility. Quantitative inheritance. Relevance in forestry. Genetic, environmental and interaction components of variation - heritability and genetic advance. Genetic basis of tree breeding. Natural variability in trees – types and importance.- forces that change variability. Provenance testing. Selection- seed production areas–seed orchards. Progeny trial and improvement of seed orchards. Combining ability and genetic gain – Hybridization in trees – back cross breeding, heterosis breeding. Breeding for resistance to insect pest's diseases, air pollution and for wood properties. Vegetative propagation and clonal forestry. Conservation of forest tree germplasm. Recent techniques in tree improvement.

Mutation breeding; Ploidy breeding. Breeding objectives and concepts of breeding in self polinated, cross pollinated and vegetatively propagated crops. Breeding of important tree species. Breeding procedures for development of hybrids, / varieties of various tree species. DUS testing, Concepts of Geographical indications. Artificial hybrids in trees-crossing in trees-problems and perspectives-crossing hybrids and hybrid breakdown. Hybrid nomenclature in trees- Future of hybrid in applied tree improvement.

Practical

Floral biology and phonological observations in some important species. Pollen morphology. Estimation of pollen sterility and viability. Emasculation and hybridization in forest tree species. Different breeding methods – flow chart. Recording observations in provenence trial. Estimation of phenotypic and genotypic coefficient of variation. Estimation of genetic advance, heritability and GCA. Exercise in plus tree selection – recording data – design and observation in teak, Anogeissus species seed orchard.

Suggested reading:

Allied T.L. White and Adams (2010). Forest Genetics. Bedell P. E. (2007). Tree Breeding for Genetic Improvement of Tropical Tree Species (1st Ed).
Surendran, C., Sehgal, R.N. and Parmathma, M. (Eds.) (2003). A text book of Forest Tree Breeding. ICAR, New Delhi.
Wright, J. (2012). Introduction to Forest Genetics. Elsevier.
Zobel, B. and Talbert, J. (2003). Applied Forest Tree Improvement. Blackburn Press.

FBT-221 Rangeland and Livestock Management 2 (1+1)

Theory

Definition, scope and importance – cattle and fodder resources of India, grassland types of India and their distribution – ecological status of Indian grasslands – principles of grassland management for maximizing forage yield and quality. Feeding habit and grazing behavior of range animals. Carrying capacity – definition, method of calculation. Establishment and management of grasslands – selection of species, planting, cultural practices – liming, fertilizer application, burning, weed control, grazing and cutting intensity. Storage of fodder – silage and hay – methods of preparation – hay banks, Fodder trees and shrubs, Forest grazing.

Definition and importance of Livestock management. Important breeds of important livestock eg. Cattle, buffalo, sheep and goat. Breeding and reproductive management for higher productivity. Feeding management – types of feedstuffs available for feeding livestock, methods of feeding. Assessing nutritive value of feed and fodder, estimation of digestible nutrients and energy in feedstuffs. Principles of rationing. Prevention and control of diseases of livestock.

Practical

Study of grassland and rangelands in the area. Different tools/instruments used in livestock management; Routine management practices followed on livestock farms; Identification of feedstuffs and their nutritive value; Nutritive requirement animals; Study of housing systems and requirements; Preservation of fodder as hay, silage and leaf meal.

Suggested reading

Banerjee, G.C. 2010. A text book on Animal Husbandry, 8th Edition, Oxford and IBH New Delhi.
Holechek J.L. et al. 1989. Range Management. Prentice Hall, New Jersey
Sastry, N.S.R. and C.K. Thomas. 2005. Livestock Production Management, Kalyani Publishers, New Delhi.
Singh R.V. 1982. Fodder trees of India. Oxford and IBH New Delhi.

FBT-321 Restoration Ecology 2(1+1)

Theory

Basic principles and planning of restoration ecology. Degraded ecosystems: Concept, classification, status, extent and causes of degraded lands/wastelands/wetlands. Soil erosion-types, causes and mechanism, measures to control erosion, ravine and sand dune formation and their control measures. Salt affected soils- classes of salt affected soils, causes, extent and their effects on plant growth and afforestation / reclamation practices. Acid soils- definition, characteristics, causes and afforestation. Water logged areas- explanation, impact on pant growth and Biodrainage techniques. Restoration of denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas. Desertification- definition,

impact and causes, prevention and counter measures (shelter belts and wind breaks). National and state level programmes on degraded lands/wasteland development. Role of Government agencies and NGO's in degraded lands/wasteland development programme.

Practical

Tree species suitable for different degraded lands. Identification and study of various degraded lands. Visit to nearby degraded lands (eroded site, ravine and sand dune, coastal area, waterlogged area, denuded hill slopes, land slips and landslides, avalanche and cold desert, mined out, dry, rocky and murramy areas) and afforestation programme.

Suggested reading:

Anilkumar and Pandey, RN 1989. Wastelands Management in India. Ashish Publishing House, New Delhi

Buol, S.W., Kole, F.D. and Mc Gracken, R.J. 1975. Soil Genesis and Classification. Oxford and IBH Publ. New Delhi.

Butler, B.E. 1980. Soil Classification for Soil Survey. Clerneder Press-Oxford Publ. Co., London.

Gregersen, H. Draper, S. and Elz. D.(eds.) 1989. People and Trees- The Role of Social Forestry in Sustainable Development EDI Seminar Series, The World Bank, Washington, D. C. 273p

Hegde NG 1987. Handbook of Wasteland Development. BAIF, Pune 102p.

Hegde NG and Abhyankar 1986 (eds). The Greening of Wastelands. BAIF, Pune 204p

IARI 1960. Soil Survey Manuel, IARI. New Delhi.

ICAR 1977. Desertification and its Control. ICAR, New Delhi 358p.

National Commission on Agriculture 1976. Report of the National Commission on Agriculture, Part ix,

Prasad, V. N. 1985. Principles and Practices of Social-Cum-Community Forestry. International Book Distributors, Dehradun, 108p

Shah, S. A. 1988. Forestry for People. ICAR, New Delhi, 147p

Sharma, S. C., Chaturvedi R. B and Mishra O. P 1990. Utilization of Wastelands for Sustainable Development In India. Concept Publishing Co. New Delhi-59, 488p

WLS-121 Wildlife Biology 2 (1+1)

Theory

Introduction to wildlife biology. Distribution of important Indian mammals, Basic requirements of wildlife – food, water, shelter, space, limiting factors .Wildlife Ecology: Biotic factors, Biological basis of wildlife, Productivity; Effect of light and temperature on animals; Wildlife Habitat: Niche, Territory, Home Range, Edge, Cruising Radius, Carrying Capacity; Animal behavior and adaptation; Habitat Improvement: Food, Water, Shelter improvement. Shift to wildlife management.

Practical

Visit to various protected areas and observations on the morphological, behavioral, feeding and reproductive activities of different species of wild animals in India. Various study methods on the wild animals, such as focal animal sampling, Sherman trapping, mist netting, camera

trapping, for identification, determination of age and sexing of animals including the small mammals. Faucal analysis of wild animals.

Suggested reading

Berwick, S.H. and Saharia, V.B. 1995. Wildlife Research and Management. Oxford University Press, New Delhi.

Dasmann, R.F. 1982. Wildlife Biology. Wiley Eastern Ltd. New Delhi.

Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.

International Zoo Books, Published by New York Zoological Society, New York.

Johnsingh, A.J.T. and N. Manjrekar. 2014. Mammals of South Asia. Vol. I. University Press, 614p.

Johnsingh, A.J.T. and N. Manjrekar. 2015. Mammals of South Asia. II. University Press, 739p.

Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press.

Mathur R. 1985. Animal Behaviour. Oxford University Press.

Menon V. 2014. Indian Mammals: A field guide. Hachette. 528p.

Mittermeier, RA Rylands, AB and Wilson DE. 2013. Handbook of the Mammals of the World - Volume 3. Lynx Edicions. 952.

Prater, S.H. (1971). The Book of Indian Animals. Oxford University press, Bombay. 324p.

Sukumar, R. Asian Elephant. Ecology and Management. Oxford University Press Cambridge.

Wilson, DE Mittermeier RA. 2009. Handbook of the Mammals of the World - Volume 1. Lynx Edicions. 728.

Wilson, DE Mittermeier RA. 2011. Handbook of the Mammals of the World - Volume 2. Lynx Edicions. 886.

WLS-221 Ornithology & Herpetology 3(2+1)

Theory

Introduction. History of ornithology in India. Origin and ancestry of birds. A brief knowledge of bird anatomy, morphology and physiology, digestive, skeletal, respiratory, excretory systems of birds. and taxidermy. Thermoregulation in birds. Bird ecology and behavior; migration and territorial behaviour, feeding, song and nests. Eggs and egg laying. Water birds, scavenger birds, frugivorous birds, pest birds, pet birds and pollinator birds. Importance of birds to different ecosystems. Birds and man. Bird watching, Bird conservation and management in India. Important Bird areas of India, Red Data Book birds of India. Introduction to Herpetology, basics of Herpetology, Amphibians and Reptiles of India, factors affecting, distribution of Herpeto-fauna, conservation issues of Herpeto-fauna. Mist netting and tagging/marking of birds for the bird migration studies. Bird census techniques.

Practical

Field identification of major birds of India. Bird watching and drawings. Study of feathers, beak and leg types of different groups of birds. Study of the nest and eggs of birds. Identification of

the poisonous and non poisonous snakes. Visit to different bird habitats. Snake rescue techniques and release in natural habitat, snake bite and its management.

Suggested reading

Ali, S. and Ripley, D.S. 1990. A compact Handbook of Birds of Indian subcontinent. Oxford University press, Bombay.

Daniel, J C. 2002. The Book of Indian Reptiles. Bombay Natural History Society, Bombay, 141pp.

Das, I. 1995. Turtles and Tortoises of India. Oxford University Press. Bombay. 176pp.

Das, I. 2002. A photographic guide to Snakes and other reptiles of India. New Holland Publishers (UK) Ltd.

Grimmet, R. Inskipp T and Inskipp, I. 2003. Handbook of Birds of Indian subcontinent. Oxford University press.

Grimmet, R. Inskipp, T and Nameer, P.O. 2007. Birds of southern India, BNHS series.

Gururaja KV. 2012. Pictorial Guide to frogs and toads of the Western Ghats. IISc. Bangalore.

Kazmierczak, K. and van Perlo B. 2000. A field guide to the birds of the Indian subcontinent, Yale University Press, New Haven. CT.

Kentwood D. Wells. 2007. The Ecology and Behavior of Amphibians. The University of Chicago Press, Chicago.

Rasmussen P C and John C. Anderton.2012. *Birds of South Asia: The Ripley guide*. Vol. I and II, Smithsonian Institution and Lynx Edicions, Washington DC and Barcelona.

Wallace GJ and HD Mahan. 2005. An Introduction to Ornithology. 3rd Ed. McMillion publishing company. New York.

Whitaker, R. and Captain, A. 2004. Snakes of India. The Field Guide. Draco Books.Chengalpattu, Tamil Nadu, xiv+479, pls, text-figs.

William E. Duellman and Linda Trueb. 1986. Biology of Amphibians. John Hopkins University Press, Maryland.

Vidyarthi, L.P. and Rai, B.K. 1985. The tribal culture of India. Concept Publ. Co., New Delhi.

WLS-411 Wildlife Management 2(1+1)

Theory

Definition, History of wildlife management and conservation in India; values of wildlife - aesthetic, recreational, scientific, educational, technological and ecological values. Zoogeographic regions of the world. Major biomes of the world – polar region, coniferous forests, temperate forests, tropical forests, grasslands, deserts, mountains, inland waters, oceans and oceanic islands. Biogeographic zones of India. Habitat management for animals. Red Data Book and red listing, IUCN revised red list categories – Extinct, Extinct in the wild, Vulnerable, Near Threatened and Least concerned. Wildlife census: Purpose and techniques. Direct and indirect methods of population estimation. Sample and total counts, indices, encounter rates and densities, block counts, road side counts, dung counts, pug mark census, water hole census, line transect- statistical analysis. Telemetry- transmitters, receivers, analysis of data, visual tagging and marking. Captive breeding for conservation. Central Zoo Authority of India. Wildlife (Protection) Act, 1972. Special projects for wildlife conservation. Project Tiger, NTCA and Musk Deer Project and Project Elephant. Introduction and reintroduction of species. Wildlife

corridors. MAB, CITES. Man-animal conflicts and management. Nutrition and Disease Management in Wild Animals .Protected areas, Concept, extent and management. Wildlife trade ecotourism in relation to wildlife.

Practical

Exercise on the census methods - direct and indirect methods and use of software for analysis. Pugmark method. Direct and indirect methods of studying food habits of different wildlife. Studying habitat management and manipulation techniques. Wildlife damage and control: Questionnaire survey. Wildlife photography.

Suggested reading

Davil, J.W. et al. 1981. Infectious diseases of wild mammals. Ed. II. Iowa State University Press, USA.

International Zoo Books, Published by New York Zoological Society, New York.

Krebs C & Davis N. 1978. Introduction to behavioral ecology. Oxford University Press.

Lever, C. 1985. Naturalised mammals of the world. John Wiley, London.

Mills, L. S. 2013. Conservation of Wildlife Populations Demography, Genetics and Management (Ed.2). Wiley-Blackwell.

Rajesh, G. 1995. Fundamentals of Wildlife Management, Justice Home, Allahabad.

Sawarkar B. Wildlife Management. Wildlife Institute of India. Dehra Dun.

PPR-211 Fundamentals of Plant Pathology 3(2+1)

Theory

Introduction to the science of phytopathology, its objectives, scope and historical background. Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases. Infection process. Survival and dispersal of plant pathogens. Plant disease epidemiology, forecasting and disease assessment. Principles and methods of plant disease management. Integrated plant disease management. Fungicides classification based on chemical nature, commonly used fungicides, bactericides and nematicides.

Practical

Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship. Identification and isolation of plant pathogens. Koch's postulates. Preparation of fungicidal solutions, slurries, pastes and their applications.

Suggested Readings:

Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.

Alexopoulos, C.J. Mims, C.W. and Blackwell, M. 1996. Introduction to Mycology Wiley Eastern Ltd., New York.

Alice, D., Jeyalaksmi, C. and Sethuraman, K (2007). Hand book on introductory Plant Pathology. A.E. Publication Coimbatore pp 178

Dhingra and Sinclair 1993. Basic Plant Pathology Methods. CBS, Publishers & Distributors, New Delhi.

Dube, H.C. (2005) An Introduction to fungi. Vikas Publishing House, pp572

Dube, H.C. 2009. Modern Plant Pathology. Student Edition, Jodhpur. 612. p

Mandahar, C.L. 1987. Introduction to Plant Viruses. Chand and Co. Pvt. Ltd., New Delhi.

Mehrotra, R.S. and Aneja, K.R. 1990. . An Introduction to Mycology. New Age International (P) Ltd., New Delhi.
Mehrotra, R.S. and A. Agarwal. Plant Pathology (2nd Edition) . Tata McGraw-Hill Publishing Company Limited, New Delhi. 846 p.
Mishra, A., Bohra, A.and A. Mishra (2005). Plant Pathology: Disease and Management. AGROBIOS India pp 766
Rangaswamy, G. and A. Mahadevan. 2008. Diseases of Crop Plants in India (4th Edition). PHI Learning Private Limited, New Delhi. 536 p.
Ravichandra, N.G. 2013.Fundamentals of Plant Pathology. PHI Hall of India, New Delhi
Sambamurthy *A textbook of Plant Pathology*-
Singh, R.S. 1982. Plant Pathogens - The Fungi. Oxford and IBH Publishing Co., New Delhi.
Singh, R.S. 1984. Introduction to the Principles of Plant Pathology. Oxford and IBH Pvt. Ltd. New Delhi. 534 p.
Singh, R.S. 1989. Plant Pathogens - The Prokaryotes .Oxford and IBH Publishing Co., New Delhi.
Singh, R.S. 2009. Plant Diseases (9th Edition). Oxford and IBH Pvt. Ltd. New Delhi. 700 p.
Tripathi D.P. (2009) Crop Diseases kalyani Publisher, New Delhi pp480
Vidhyasekaran, P. (2007). Concise Encyclopedia of Plant Pathology, VIVA Books, New Delhi.
Vishunavat, K and Kolte, S.J. (2005) Essentials of Phytopathological Techniques. Kalyani Publisher, New Delhi pp 217.

PPR-212 Fundamentals of Entomology 3(2+1)

Theory

Introduction to phylum arthropoda. Importance of class Insecta. Insect dominance. History of entomology in India, Importance of entomology in different fields. Definition, division and scope of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetalia. Structure, function of cuticle &moulting and body segmentation, Anatomy of digestive, Circulatory, Sensory, respiratory, glandular, excretory, nervous and reproductive systems. Types of reproduction. Postembryonic development-eclosion. Matamorphosis. Types of egg larvae and pupa. Classification of insectsupto orders, sub-order and families of economic importance and their distinguished characters. Plant mites – morphological features, important families with examples.

Practical

Insect collection and preservation. Identification of important insects. General body organization of insects. Study on morphology of grasshopper or cockroach. Preparation of permanent mounts of mouth parts, antennae, legs and wings. Dissection of grasshopper and caterpillar for study of internal morphology. Observations on metamorphosis of larvae and pupae. Dissection of cockroaches.

Suggested Reading:

Awasthi, V.B. 1997. *Introduction to general and applied entomology*. Scientific Publishers, Jodhpur, 379 p.
Borror, D.J., C.A. Triple Horn and N.F.Johnson. 1987. *An introduction to the study of insects (VI Edition)*. Harcourt Brace College Publishers, New York, 875p.
Chapman, R.F. 1981. The Insects: Structure and function. Edward Arnold (Publishers) Ltd, London, 919p.
Chapman, R.F. 2006 Tthe Insect Structure and Function fourth edition Cambridge University Press UK pp770
David, B.V.andAnanthakrishnan, T.N. (2006) General and Applied Entomology, Tata McGraw-Hill Publishing Company Limited, New Delhi.pp1184

Kachhwaha, N. (2011) Principle of Entomology Basic and Applied AGROBIOS, Jodhpur pp561
Gullan, P.J. and Cranston, P.S. 2001. *The insects- An outline of entomology*, II edition, Chapman & Hall, Madras, 491p.
James, L, Nation. CRC Press, Insect Physiology and Biochemistry.Washington
Lewin H. and Devasahayam. Practical manual of entomology insect and non-insect pests.
Mani, M.S. 1968. *General entomology*. Oxford and IBH Publishing Co. Pvt Ltd., New Delhi, 912p.
Mathur, Y.K. and K.D. Upadhyay (2005): A Text Book of Entomology (Fifth Edition): Aman Publishing house, Meerut pp388
Nayar, K.K., T.N.Ananthakrishnan and B.V. David. 1976. *General and applied entomology*, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.
Pant, N.C. and Ghai, S. 1981Insect physiology and anatomy, ICAR, New Delhi .
Pedigo, L.P. 1999. *Entomology and pest management*. III Edition. Prentice Hall, New Jersey, USA, 691p.
Rajagopal, D and Chakravarthy, A.K. (2012) Insects. Avishkar, Publishers, Distributors Jaipur pp 100
Richards, O.W. and R.G. Davies. 1977. *Imm's general text book of entomology*, Vol.1&2, Chapman and Hall Publication, London, 1345p.
Romoser, W.S. 1988. *The Science of Entomology*, McMillan, New York, 449p.
Saxena, S.C. 1992. *Biology of insects.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 366p.
Selvanarayanan, V. and Arivudainambi, S., (2005) Introductory Entomology, Manivasagarpathippagam Chennai pp 262.
Snodgrass, R.E. 2001.Principles of Insect Morphology.CBS Publishers and Distributors, New Delhi
Srivastava, P.D. and R.P.Singh. 1997. *An introduction to entomology*, Concept Publishing Company, New Delhi, 269p.
Tembhare, D.B. 1997. *Modern Entomology*. Himalaya Publishing House, Mumbai, 623p.
Wilson, G.F. (2010) Horticultural pest Detection and their control, Biotech Book Delhi pp 240.

PPR-221 Insect Pests of Fruit, Plantation, Medicinal and Aromatic Crops 3(2+1)

Theory

General – economic classification of insects; Bio-ecology and insect-pest management with reference to fruit, plantation, medicinal and aromatic crops; pest surveillance. Distribution, host range, bio-ecology, injury, integrated management of important insect pests affecting tropical, sub-tropical and temperate fruits, plantation, medicinal and aromatic crops like coconut, areca nut, oil palm, cashew, cacao, tea, coffee, cinchona, rubber, betel vine senna, neem, belladonna, pyrethrum, costus, crotalaria, datura, dioscorea, mint, opium, *Solanumkhasianum* and **Aonla**. Storage insects – distribution, host range, bio-ecology, injury, integrated management of important insect pests attacking stored fruits, plantation, medicinal and aromatic crops and their processed products. Insecticide residue problems in fruit, plantation, medicinal and aromatic crops and their maximum residue limits (MRLs).

Practical

Study of symptoms of damage, collection, identification, preservation, assessment of damage and population of important insect – pests affecting fruits, plantation, medicinal and aromatic crops in field and storage.

Suggested Reading:

Atwal. A. S. Agricultural pests of south Asia and their management

Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.

Butani, D.K.1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi

David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.

David. V. Alford. Pest of fruit crops. A. M. Ranjith. Identification and management of Horticultural pest.

Fryer. Insect pest of fruit crops

Mark Vernon Slingerlands and C. R. Crosby. Manual of fruit insects

Metcalf, R.L and Luckman,W.H.1982. Introduction to Insect pest management. Wiley Inter Science Publishing, New York

Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.

Rachna and Bennakumari. Pest management and residual analysis in horticultural crop

Ramnivassharma. Identification and management of horticulture pest.

Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.

Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur.

Srivastav K. P. and Y. S. Ahawat. Pest management in citrus

PPR-222 Diseases of Fruit, Plantation, Medicinal and Aromatic Crops 3(2+1)

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of the diseases of fruits, plantation, medicinal and aromatic crops *viz* mango, banana, grape, citrus, guava, sapota, papaya, jack fruit, pineapple, pomegranate, ber, apple, pear, peach, plum, almond, walnut, strawberry, areca nut, coconut, oil palm, coffee, tea, cocoa, cashew, rubber, betel vine senna, neem, hemp, belladonna, pyrethrum, camphor, costus, crotalaria, datura, dioscorea, mint, opium, *Solanumkhasianum*, Tephrosia,**aonla and bael**. Important post-harvest diseases of fruit, plantation and medicinal and aromatic crops and their management.

Practical

Observations of disease symptoms, identification of casual organisms and host parasite relationship of important diseases. Examination of scrapings and cultures of important pathogens of fruits, plantation, medicinal and aromatic crops.

Suggested Reading:

Agrios, G.N. 2005. Plant Pathology (5th Edition). Elsevier, Academic Press, New York. 922 p.

Alfred Steferud *Diseases of Plantation Crops*-, Biotech books.

Anna L *A colour atlas of Post-Harvest Diseases and Disorders of fruits and vegetables* -. Snowdon, CRC Press.

Anna L.Snowdon*A colour atlas of Post-Harvest Diseases and Disorders of fruits and vegetables* .CRC Press, New Delhi.

Arjunan, Karthikeyan, Dinakaran, Raghuchander, 1999.*Diseases of Horticultural Crops*. Dept. of Plant Pathology, TNAU, Coimbatore
Chadha, K.L. 2002.*Hand Book of Horticulture*. ICAR, New Delhi.
Darwin L. Christdhar Henry and H. LewinDevasahayam, *An Illustrated Handbook*. New India publishing.Agency
Darwin L.Christdhar Henry and H. LewinDevasahayam. *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook, New India publishing. Agency.
Godara S.L., BBS Kapoor, B.S. Rathore. *Disease management of spice crops*.,Madhu Publications.
Godara, S.L. BBS Kapoor, B.S. Rathore *Disease management of spice crops*-, Madhu Publications.
Indra, N., Aruna, P., and Ponnuswami, V (2012) Disease Management of horticultural crops under protected cultivation. Pointer Publisher Jaipur pp180.
Mehrotra, R.S. and A. Agarwal. Plant Pathology (2nd Edition). Tata McGraw-Hill Publishing Company Limited, New Delhi. 846 p.
Mishra, A. Bohra A. and A. Mishra (2005). Plant Pathology: Disease and Management. AGROBIOS India pp 766
Mukerji, K.G. 2004 Fruit and Vegetable Diseases. Kluwer Academic Publisher Dordrecht pp554
Pathak, V.N. 1980.*Diseases of Fruit Crops*. Oxford IBH Publishing Co. Pvt. Ltd., New Delhi.
Rangaswamy, G. and A. Mahadevan. 2008. Diseases of Crop Plants in India (4th Edition). PHI Learning Private Limited, New Delhi. 536 p.
Saha, L.R. 2002.*Hand Book of Plant Diseases*. Kalyani Publishers, New Delhi.
Saha, L.R. (2008) Hand Book of Plant Diseases. Kalyani Publisher, New Delhi pp 457
Singh, R.S. (1984). Diseases of Fruit Crops, Oxfords and IBH Publishing co. Pvt. Ltd. New Delhi pp 310
Singh, R.S. 2009. Plant Diseases (9th Edition). Oxford and IBH Pvt. Ltd. New Delhi. 700 p.
Srikant Kulkarni, Yashoda R. Hedge, *Diseases of Plantation crops and their management*-Agrotech publication Academy.
Thind T.S. (2005). Diseases of Fruits and Vegetables and Their Management. Kalyani Publisher, New Delhi pp 474
Tripathi D.P. (2009) Crop Diseases, Kalyani Publisher, New Delhi pp 480
Verma L.R. and R.C. Sharma. *Diseases of horticultural Crops*-, Indus Publishers
Verma L.R. and R.C. Sharma. *Diseases of horticultural Crops*. Indus Publishers,New Delhi.
Yashoda R. Hedge. *Diseases of Plantation crops and their managemen*t. Srikant Kulkarni, Agrotech publication Academy.

PPR-311 Insect Pests of Vegetable, Ornamental and Spice Crops 3(2+1)

Theory

Economic importance of insects in vegetable, ornamental and spice crops -ecology and pest management with reference to these crops. Pest surveillance in important vegetable, ornamental and spice crops. Distribution, host range, bio-ecology, injury, integrated management of important insect-pests affecting vegetable, ornamental and spice crops. Important storage insect-pests of vegetable, ornamental and spice crops, their host range, bio-ecology, injury and integrated management. Insect –pests of processed vegetables and ornamental crops, their host

range, bio-ecology, injury and integrated management. Insecticidal residue problems in vegetables and ornamental crops, tolerance limits etc.

Practical

Study of symptoms, damage, collection, identification, preservation, assessment of damage/population of important insect-pests affecting vegetable, ornamental and spice crops in field and during storage.

Suggested reading:

Atwal. A. S. Agricultural pests of south Asia and their management

Ayyar, T.V.R. 1963. Hand book of entomology for south India. Govt. press Madras, 516p.

Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi.

Butani, D.K. 1984.Insects and Fruits. Periodical Expert Book Agency, New Delhi

David B V and Kumarswami, T, 1982. Elements of Economic Entomology. Popular Book Department, Madras, 536p.

Dhalinal, .G.S. and Ramesh Arora Integrated Pest Management Concept and Approaches. Kalyani Publishers, Ludhiana.

Emmanuel, N, A. Sujatha, T.S.K. K. KiranPatro, MLN Reddy, B. Srinivasulu, TSSK SammuelPatro. Text Book on Integrated Pest Management of Horticultural Crops Astral International Publishers, New Delhi.

Srivastava, K.P. Dhamo K. Butani Pest management in vegetables – Part-2. Researcho Book Centre, 1998

Srivastava, K.P. A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

Metcalf,R.LandLuckman,W.H.1982. IntroductiontoInsectpestmanagement. WileyInterSciencePublishing,NewYork

Nair M R G K, 1995, Insect and Mites of Crops in India, ICAR, New Delhi.

Srivastava, P. Dhamo K. Butani Pest management in vegetables – Part1. Researcho Book Centre, 1998

Rachna and Bennakumari. Pest management and residual analysis in horticultural crop

Ramnivas Sharma. Identification and management of horticulture pest.

Ranjit, P., 2012, Entomological Techniques in Horticultural Crops, New India Publishing Agency.

Reddy, P. P., 2010, Plant Protection in Horticulture Vol. 1, 2 & 3, Scientific Publishers, Jodhpur

Sathe. T. V. Pests of ornamental plants.

PPR-312 Diseases of Vegetable, Ornamental and Spice Crops 3(2+1)

Theory

Etiology, symptoms, mode of spread, epidemiology and integrated management of diseases of the following vegetables, ornamental and spice crops: tomato, brinjal, chilli, bhindi, cabbage, cauliflower, radish, knol-khol, pea, beans, beet root, onion, garlic, fenugreek, coriander, cumin, **fennel**, **Cucurbits,** ginger, potato, **carrot, sweet potato, yam, colocassia**, turmeric, pepper, cardamom, nutmeg, clove, cinnamon, jasmine, rose, crossandra, tuberose, gerebera, anthurium, geranium, **dahelia, chrysanthemum,** and **marigold.** Important post-harvest diseases of vegetables and ornamental crops and their management.

Practical

Observations of symptoms, causal organisms and host parasitic relationship of important diseases, examination of cultures of important pathogens of vegetables, ornamental and spice crops in field as well as in protected cultivation.

Suggested Reading:

Arjunan, G. Karthikeyan, G. Dinakaran, D. Raguchander, T. 1999. *Diseases of Horticultural Crops.* .Dept. of Plant Pathology,Tamilnadu Agricultural University Coimbatore.

Darwin L.Christdhar Henry and H.LewinDevasahayam *Crop diseases: Identification, Treatment and Management*. An Illustrated Handbook –, New India publishing Agency

Godara, S.L. BBS Kapoor, B.S. Rathore. *Disease management of spice crops*-, Madhu Publications

Rangaswamy, G. and A. Mahadevan. 2008. Diseases of Crop Plants in India (4th Edition). PHI Learning Private Limited, New Delhi. 536 p.

Saha, L.R. (2008) Hand Book of Plant Diseases. Kalyani Publisher, New Delhi pp 457

Singh, R.S. (1994). Diseases of Vegetable Crops, Oxfords and IBH Publishing co. Pvt. Ltd. New Delhi pp 362

Singh, R.S. 2009. Plant Diseases (9th Edition). Oxford and IBH Pvt. Ltd. New Delhi. 700 p.

Sohi, H.S. 1992. *Diseases of Ornamental plants in India*. ICAR, New Delhi

Srikant Kulkarni, Yashoda R. Hedge. *Diseases of Plantation crops and their management*-, Agrotech publication Academy

Additional Suggested Reading may be added:

Agrios, G.N. 2005. Plant Pathology (5th Edition). Elsevier, Academic Press, New York. 922 p.

Mehrotra, R.S. and A. Agarwal. Plant Pathology (2nd Edition). Tata McGraw-Hill Publishing Company Limited, New Delhi. 846 p.

Mishra, A. Bohra, A. and Mishra A. (2005). Plant Pathology: Disease and Management. AGROBIOS India pp 766

Mukerji, K.G. 2004 Fruit and Vegetable Diseases. Kluwer Academic Publisher Dordrecht pp554

Thind, T.S. (2005). Diseases of Fruits and Vegetables and Their Management. Kalyani Publisher, New Delhi pp 474

Tripathi D.P. (2009) Crop Diseases, Kalyani Publisher, New Delhi pp 480

PPR-321 Apiculture, Sericulture and Lac culture 2(1+1)

Theory

Introduction to beneficial insects. Importance and History of apiculture. Species of honey bees, Rock bee, Littlebee, Indian bee, European bee, Italian bee and Dammar bee, lifecycle and caste determination. Bee colony maintenance, bee colony activities, starting of new colony, location site, transferring colony, replacement of queen, combining colonies, swarm prevention, colony management in different seasons, Equipment for apiary, types of bee hives and their description. Bee pasturage. Honey extraction, honey composition and value, bee wax and tissues.. Importance, History and development in India of sericulture, silkworms kinds and their hosts, systematic position, distribution, lifecycles in brief, Silk glands. Mulberry silkworm-morphological features, races, rearing house and equipments, disinfection and hygiene. Grainage acid treatment, packing and transportation of eggs, Incubation, black boxing, hatching of eggs. Silkworm rearing young age /chawkirearing and old age rearing of silkworms. Feeding, spacing,

environmental conditions and sanitation. Cocoon characters colour, shape, hardiness and shell ratio. Defective cocoons and stifling of cocoons. Uses of silk and by-products. Economics of silk production. Moriculture-Mulberry varieties, package of practices, Pests and diseases and their management. Lac growing areas in India, Lac insects, biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac-insects.

Practical

Honey bee colony, different bee hives and apiculture equipment. Summer and Wintermanagement of colony. Honey extraction and bottling. Study of pests and diseases of honeybees. Establishment of mulberry garden. Preparation of mulberry cuttings, planting methods under irrigated and rainfedconditions. Maintenance of mulberry garden-pruning, fertilization, irrigation and leaf harvest. Mulberry pests and diseases and their management and nutritional disorders. Study of different kinds of silkworms and mulberry silkworm morphology, silk glands. Sericulture equipmentsfor silkworm rearing. Mulberry silkworm rearing room requirements. Rearing of silkworms-chalky rearing. Rearing of silkworms late age silkworm rearing and study of mountages. Study of silkworm pests and their management. Study of silkworm diseases and its management. Lac insects-biology, behaviour, lac cultivation, food plants, pruning, inoculation, cropping, kinds of lac. Enemies of lac insects.

Suggested Reading:

David B.R. and V.V.Ramamurthy. Elements of Economic Entomology, 7th Edition. Namrutha Publications, Chennai

Ganga, G. and SulochanaChetty, J. 1997. An introduction to Sericulture (2nd Edn.). Oxford & IBH publishing Co. Pvt. Ltd., New Delhi.

Glover, P.M. 1937. Lac cultivation in India. Indian Lac Research Institute, Ranchi.

Jolly, M.S. 1987. "Appropriate sericulture techniques" International centre for training and ResearchinTropicalSericulture,Mysore,209.

Krishnaswamy, S. (Ed). 1978. Sericulture Manual - Silkworm Rearing. FAO Agrl. Services bulletin, Rome.

Mishra, R.C. and Rajesh Gar. 2002. Prospective in Indian Apiculture. Agrobios, Jodhpur.

Narasaiah. M.L. Problems and Prospects of Sericulture. Discovery publishing House Pvt. Ltd.

Paul De Bach and Devid Rosen 1991. Biological control by natural enemies. Cambridge University Press; 2 edition (27 June 1991)

Shinde YA and BR Patel. Sericulture in India

Singh, D and Singh, D.P. 2006. A hand book of Beekeeping, Agrobios (India).

Singh, S. 1975. Bee keeping in India. ICAR, New Delhi.

Singh, S., 1975. Bee keeping in India – ICAR, New Delhi., 214p.

Srivastava, K.P. A Text Book on Applied Entomology Vol. I&II. , Kalyani Publishers, Ludhiyana

Sunita, N.D, Guled, M.B, Mulla S.R and Jagginavar, 2003, Beekeeping, UAS Dharwad

Tribhuwan Singh. Principles and Techniques of Silkworm Seed Production, Discovery publishing House Pvt. Ltd

PPR-322 Nematode Pests of Horticultural Crops and their Management 2(1+1)

Theory

History and development of nematology - definition, economic importance. General characters of plant parasitic nematodes, their morphology, taxonomy, classification, biology, symptomatology and control of important plant parasitic nematodes of fruits – (tropical, sub-

tropical and temperate) vegetables, tuber, ornamental, spice and plantation crops. Role of nematodes in plant disease complex. Integrated nematode management.

Practical

Methods of sampling and extraction of nematodes from soil and plant parts, killing, fixing and preparation of temporary and permanent nematode mounts. Nematicides and their use. Collection and preservation of 20 plant species/parts damaged by plant parasitic nematodes.

Suggested Reading:

Jonathan, E.I, I. Cannayane, K. Devrajan, S. Kumar, S. Ramakrishan, Agricultural Nematology. TNAU, Coimbatore.

Butani, D.K. 1984. Insects and Fruits. Periodical Expert Book Agency, New Delhi

Gopal Swaroop and Das Gupta 1986.ICAR, New Delhi. Plant Parasitic Nematodes of India Problems and Progress.

Metcalf, R.L and Luckman, W.H. 1982. Introduction to Insect pest management Wiley Inter Science Publishing, New York.

Nair, M.R.G.K. 1975. Insects and Mites of Crops in India. ICAR, New Delhi

Upadhyay, K.D and Dwivedi, K. 1997. A text book of plant nematology. Amman Publishing House Aman publishing house, Meerut

Vasanth Raju David, B. 2001. Elements of economic entomology. Popular book Depot, Chennai.

Additional Suggested Reading may be added:

Bajaj, H.K., Kanwar, R.S. and Gupta, D.C. (2011). Handbook of Practical Nematology. Scientific Publisher, Jodhpur pp150

Bohra, A., and Anamika (2012). Plant Nematology: A Fundamental Approach. Agrobios Jodhpur.pp286.

Manjunath, B., and Srinivas, N., Plant Nematology at a Glance New Vishal Publication New Delhi pp264

Reddy, P.P. 2007 Integrated Nematode Management in Horticultural Crops. Scientific Publisher, Jodhpur pp300

Reddy, P.P. 2008 Disease of Horticultural Crops: Nematode Problem and their Management. Scientific Publisher, Jodhpur pp379.

Wallia, R.K. And Bajaj, H.K. (2013) Text Book on Introductory Plant Nematology. ICAR, New Delhi pp227.

NRM-111 Fundamentals of Soil Science 3 (2+1)

Theory

Composition of earth's crust, soil as a natural body – major components. **Soil forming rocks and minerals; weathering and processes of soil formation.** Physical parameters; texture – definition, methods of textural analysis, stock's law, assumption, limitations, textural classes, use of textural triangle; absolute specific gravity/particle density, definition, apparent specific gravity/bulk density – factors influencing, field bulk density. Relation between BD (bulk density), **PD (particle Density).** Pore space – definition, factors affecting capillary and non-capillary porosity. Soil colour – definition, its significance, colour variables- hue, value and chroma. Munsell colour chart, factors influencing-parent material, soil moisture, organic matter. Soil structure-definition, classification-**type, class & grade** of structure, factors influencing genesis of soil structure. Soil consistency, plasticity, Atterberg's constants. Soil air, air capacity, composition, factors influencing, amount of air space, soil air renewal. Soil temperature, sources

and distribution of heat, factors influencing, measurement. Chemical properties- soil colloids, organic, humus, inorganic, secondary silicate, clay, hydrous oxides. Ion exchange, cation-anion, importance. Soil water, forms-hygroscopic, capillary and gravitational, soil moisture constants, hygroscopic coefficient, wilting point, field capacity, moisture equivalent, maximum water holding capacity, energy concepts, PF scale. Measurement- gravimetric, electric and tensiometer methods, pressure plate and pressure membrane apparatus, Neutron probe, soil water movement. **Soil Classification–Taxonomy- soil orders & characteristics**, aerial photography–satellite images of soil features–their interpretation; land capability classification; soil of different eco-systems and their properties. Objectives of soil science research institute in India (NBSS&LUP, IISS, LTFE & NSSTL). Management of Soil Crusting, Soil Compaction and Soil Compression. Methods and objective of soil survey, Remote sensing application in soil and plant Studies, Soil degradation.

Practical

Collection and preparation of soil samples, Description of soil profile in the field. Estimation of moisture, EC, pH, bulk density and **particle density**. Determination of pore space of soil. Textural analysis of soil by Hydrometer method. **Identification** of minerals and their abundance. Determination of Soil colour using Munsell Chart. Estimation of water holding capacity and hydraulic conductivity of soils. Estimation of Infiltration rate using double ring infiltrometer method. Estimation of soil moisture using gypsum block and neutron probe method. Soil compaction measurement with Pentrometer. Determination of filed capacity and permanent wilting point of soil. Determination of soil water potential characteristic curves by tensiometer and pressure plate apparatus. Aggregate size distribution analysis of soil. Air capacity of soil by field method.

Suggested reading:

Brady Nyle C and Ray R Well, 2014. *Nature and properties of soils*. Pearson Education Inc., New Delhi.

Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. IARI, New Delhi.

Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.

Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.

Biswas, T.D. and Mukharjee, S.K., 2015. *Text Book of Soil science*. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.

Brady, N.C., 1995. *The Nature and properties of Soils*. Macmillan Publishing Co, New York.

Ghildyal, B.P. and Tripathi, R.P., 1987. *Soil Physics*. Acad. Press. New York.

Kolay, A.K., 1983. *Basic concepts of Soil Science*. Wiley Eastern Ltd., New Delhi

Brady, N. C. and Weil, R. R., 2010. *Elements of the Nature and Properties of Soils* (3rd Edition), Pearson Education, New Delhi.

Foth, H.D., 1991. *Fundamentals of Soil Science* (8th Edition), John Wiley & Sons, New Delhi.

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Khan, T. O. 2013 Forest Soils: *Properties and Management*. Springer International Publishing, Switzerland

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Gupta, P.K. 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).

Jaiswal, P.C. 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.
Jackson, M. L. 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher
Mehra, R. K. 2004. *Textbook of Soil Science*, ICAR Publication, New Delhi.

NRM-112 Introduction to Agronomy and Horticulture 3 (2+1)

Theory

Agronomy, scope and its role in crop production-Major Field crops of India – classification, area, distribution and productivity of major Field crops. Farming and cropping systems – mono, sole and multiple cropping, relay, sequential and inter cropping. Tillage- definition- objectives – types of tillage- tillage implements – tilth - characteristics of good tilth - Soil productivity and fertility- Crop nutrition – nutrients –classification – Nutrient sources- organic manures – fertilizers – biofertilizers- Integrated Nutrient Management-Importance of water in plant growth-Soil properties influencing moisture availability – texture, structure and organic matter status-Irrigation and drainage. Weed control – definition and characteristics of weeds, classification of weeds – damages due to weeds - benefits of weeds. -Control vs prevention of weeds – methods of weed control-Classification of herbicides–Integrated weed management. Soil and its management-Definitions and importance of horticulture- Economic importance and classification of horticultural crops and their culture and nutritive value- area and production- exports and imports- fruit, vegetables, plantation and spice crops-soil and climate–principles-planning and layout- management of orchards- planting systems and planting densities- Principles and methods of pruning and training of fruit, plantation crops-use of growth regulators in horticulture crops-Horticultural zones of state and country.

Practical

Identification of field crop and tillage implements. Preparation of seed beds, identification of fertilizers and manures – mixing chemical fertilizers – calculating fertilizer requirements. Identification of green manure plants. Identification of important weeds of the region with particular reference to forest plantations. Preparation of weed herbarium. Calculations of spray volume and herbicide concentrations. Methods of application of herbicides. Identification of horticultural crops-garden tools and implements. planning and layout of orchard and plantations. Digging and filling of pits for fruit and plantation crops-planting systems, training and pruning of orchard trees-preparation and application of regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits-bearing habits and maturity standards, harvesting, grading, packaging and storage.

Suggested readings

Agrawal, R.L. 1980. Seed technology. Oxford & IBH Publishing Co., New Delhi
Balasubramaniyan, P and Palaniappan, S.P.. 2001. Principles and Practices ofAgronomy. Agro Bios (India)Ltd., Jodhpur.
Bose, T.K. 1985. Fruits of India- Tropical and subtropical. Naya Prakash, Calcutta
Brady, N.C. and Well, R.R. 2002. The Nature and Properties of Soils (13th ed.). Pearson Education, Delhi.
De, G.C. 1989. Fundamentals of Agronomy. Oxford & IBH Publishing Co., New Delhi

Havlin, J. L., Beaton, J. D., Tisdale, S.L., and Nelson, W.L. 2006. Soil Fertility and Fertilizers: An Introduction to Nutrient Management (7th ed.). Pearson Education, Delhi.

ICAR.2006. Hand book of Agriculture, ICAR, New Delhi.

Nair, P.K.R. 1979. Intensive multiple cropping with coconuts in India. Verlag Paul Pary, Berlin

Palaniappan, S.P. 1988. Cropping systems in the tropics - Principles and management. Wiley Eastern Limited, New Delhi

Randhawa, M.S. 1982. History of agriculture in India, Vol I, II & III. ICAR, New Delhi

Reddy. T.Y and Reddy, G.H.S.1995. Principles of Agronomy, Kalyani Publishers, Ludhiana.

Reddy.S.R.1999. Principles of Agronomy, Kalyani Publishers, Ludhiana.

Sankaran, S. and Subbiah Mudaliar, V.T. 1991. Principles of Agronomy. The Bangalore Printing & Publishing Co., Bangalore

Tisdale, S.L. et al. 1985. Soil fertility and fertilizers. Macmillan Pub. Co., New York

NRM-113 Fundamentals of Geology and Soils 3 (2+1)

Theory

Introduction to geology - its significance, composition of earth's crust, soil as a natural body - major components by volume. Pedology -rocks- types – igneous, sedimentary and metamorphic, classification - soil forming minerals - definition, classification-silicates, oxides, carbonates, sulphides, phosphates-occurrence. Weathering of rocks and minerals -weathering factors - physical-chemical-biological agents involved, weathering indices. Factors of soil formation-parent material, climate, organism, relief, time. Soil forming processes-eluviations and illuviation, formation of various soils. **Physical parameters**- texture-definition, methods of textural analysis, Stokes law, textural classes, use of textural triangle, absolute specific gravity-definition apparent specific gravity/bulk density-factors influencing-field bulk density, relation between bulk density-particle density. Pore space-definition-factors affecting capillary and non capillary porosity- soil colour-definition-its significance - colour variable-hue, value, chroma, Munsell colour chart-factors influencing-parent material-soil moisture-organic matter. Soil structure-definition-classification-**type, class and grade of structure**-factors influencing genesis of soil structure, soil consistency, plasticity-Atterberg's constants. Soil air-composition, factors influencing-amount of air space. Soil temperature-sources and distribution of heat-factors influencing-measurement. **Chemical properties** -soil colloids organic- humus-inorganic-secondary silicate-clay-hydrous oxides. Soil organic matter decomposition - concept of pH - soil acidity -nutrient availability-soil buffering capacity – a brief overview of saline, sodic and calcareous soils. Soil water-forms-hygroscopic, capillary and gravitational-soil moisture constants-hygroscopic coefficient-wilting point-field capacity-moisture equivalent, maximum water holding capacity, energy concepts-pF scale measurement-gravimetric-electric and tensiometer methods-pressure plate and pressure membrane apparatus-Neutron probe-soil water movement-saturated and unsaturated, infiltration and percolation. Elementary knowledge of soil classification – soil orders. Forest soils- characteristics- distinguishing features- **with reference to** physical and chemical properties compared to agricultural soils.

Practical

Identification of rocks and minerals; Collection and preparation of soil samples; Soil analyses for moisture, colour, bulk density, **particle density, percent porosity**, organic matter, pH, EC;

Textural analysis by hydrometer method; Study of soil profile; Practical's on introduction to Tensiometer, pressure plate and neutron probe etc.

Suggested readings:

Biswas, T.D. and Mukherjee, S. K. 1987. Test Book of Soil Science, Tata McGraw Hill Publishing Co., New Delhi

Brady, N. C. 1990. Nature and Properties of Soils. 10th ed., Macmillan Publishing Co. Inc., New York

Foth, H.D. & Turk, L. M.1972. Fundamental of Soil Science. 5th ed. Wiley Eastern Pvt. Ltd., New Delhi

Gupta, P,K. 2007. Soil, Plant, Water and Fertilizer Analysis. Published by AGROBIOS (India), Jodpur

Indian society of soil science (ISSS). 2002. Fundamentals of Soil Science. Published by Indian Society of Soil Science, IARI, New Delhi

Jaiswal, P.C. 2006. Soil, Plant and Water Analysis. 2nd Edn. Kalyani Publishers, Ludhiyana

Pritchett and Fisher R, F. 1987. Properties and Management of Forest Soils. John Wiley, New York.

Mehra, R. K. 2004. *Textbook of Soil Science*, ICAR Publication, New Delhi.

Dilip Kumar Das, 2015. Introductory Soil Science. Kalyani Publishers, Ludhiana.

NRM-121 Soil Fertility and Nutrient Management 2 (1+1)

Theory

Introduction to soil fertility and productivity- factors affecting. Essential plant nutrient elements-functions, deficiency **symptoms**, transformations and availability. Acid, calcareous and salt affected soils – characteristics and management. Soil organic matter, Role of microorganisms in organic matter- decomposition – humus formation. Importance of C:N ratio and pH in plant nutrition, soil buffering capacity. Integrated plant nutrient management. Soil fertility evaluation methods, critical limits of plant nutrient elements and hunger signs. NPK, **Secondary and micronutrient** fertilizers: composition and application methodology. Luxury consumption, nutrient interactions, deficiency symptoms, visual diagnosis. Soil test crop response and targeted yield concept. Manures classification and Biofertilizer. Fertilizer control order. Properties and fate of major and micronutrient in soils. Fertilizer use efficiency and management. Plant nutrient toxicity symptoms and remedies measures. Effect of potential toxic elements in soil productivity.

Practical

Analysis of soil for organic matter, available N,P,K and Micronutrients and interpretations. Gypsum requirement of saline and alkali soils. Lime requirement of acid soils. Determination of Calcium, Magnesium and Sulphur in soil. Sampling of organic manure and fertilizer for chemical analysis. Physical properties of organic manure and fertilizers. Total nitrogen in urea and farmyard manure. Estimation of ammonical nitrogen and nitrate nitrogen in ammonical fertilizer. Fertilizer testing laboratory visits.

Suggested readings:

Yawalkar K S, Agarwal JP and Bokde S, 1992. *Manures and Fertilizers.* Agri. Horticultural Publishing House, Nagpur.

Tandon HLS, 1994. *Fertilizers Guide.* Fertilizers Development Consultation Organization, New Delhi.

Seetharaman S, Biswas B C, Yadav D S and Matheswaru S. Usage 1996. *Hand Book on Fertilizers*. Oxford and IBH Publishing Company, New Delhi.

The fertilizer Association of India, Shaheed Jit singh marg, New Delhi, 1985. Fertilizer control order

Ranjan Kumar Basak , 2000. *Fertilizers A Text book.* Kalyani publishers, New Delhi.

British Crop Production Council, U.K., 1995. The Pesticide Manual, A – World Compendium.

Sree Ramulu US, 1991. *Chemistry of Insecticides*. Oxford and IBH Publishing and Fungicides Company, New Delhi.

Nene Y L and Thapliyal P N, 1991. *Fungicides in plant disease control*. Oxford and IBH Publishing company, New Delhi.

Havlin *et al.* 2014. *Soil Fertility and Fertilizers: An Introduction to Nutrient Management* (8th Edition), PHI Learning Pvt. Ltd., Delhi.

Binkley, D. and R. Fisher, 2012. *Ecology and Management of Forest Soils* (4th Edition), John Wiley & Sons Singapore Pvt. Ltd., Singapore

Reddy M. V., 2001. *Management of Tropical Plantation Forests and Their Soil Litter System-Litter, Biota and Soil Nutrient Dynamics*, Science Publishers, U. S.

Khan, T. O., 2013. *Forest Soils: Properties and Management*. Springer International Publishing, Switzerland

Brady, N. C. and Weil, R. R., 2010. E*lements of the Nature and Properties of Soils* (3rd Edition.), Pearson Education, New Delhi

Das, D .K., 2011. Introductory Soil Science (3rd Edition), Kalyani Publisher, Ludhiana (India).

Indian Society of Soil Science, 2002. *Fundamentals of Soil Science*. Indian Society of Soil Science, IARI, New Delhi.

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Gupta, P.K., 2009. *Soil, Plant, Water and Fertilizer Analysis* (2nd Edition), AGROBIOS, Jodhpur (India).

Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.

Jackson, M. L., 2012. Soil Chemical Analysis: Advanced Course, Scientific Publisher

J. Benton Jones, Jr., 2012. *Plant Nutrition and Soil Fertility Manual* (2nd Edition), CRC Press, USA.

Mengel, *et al.,* 2001. *Principles of Plant Nutrition* (5th Edition), Springer

Kanwar, J.S. (Ed)., 1976. *Soil Fertility : Theory and Practice*, ICAR, New Delhi

Bear, F.E., 1964. *Chemistry of the Soil.* Oxford and IBH Publishing Co., New Delhi

Richards, L.A., 1968. *Diagnosis and Improvement of Saline and Alkaline soils*. Oxford & IBH Publishing Co. New Delhi(USDA Hand Book No. 60)

Chopra, S.C and Kanwar, J.S., 1976. *Analytical Agricultural Chemistry*. Kalyani Publishers, Ludhiana.

Tisdale, S.L. Nelson, W.L. and Beaton, J.D., 1993. *Soil Fertility and Fertilizers*. Macmillan Publishing Company, New York

Yawalkar, K.S. Agarwal, J.P. and Bokde, S., 1977. *Manures and Fertilizers*. Agri-Horticultural Publishing House, Nagpur

Seetharamaan, S. Biswas, B.C. Maheswari, S. and Yadav, D.S., 1986. *Hand Book on Fertilizers Technology*. The Fertilizers Association of India, New Delhi.

NRM-122 Water Management in Horticultural Crops 2(1+1)

Theory

Importance of water, water resources in Rajasthan. Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – water budgeting–distribution of soil moisture –rooting characteristics – moisture extraction pattern. Water requirement of horticultural crops – lysimeter studies – Plant water potential climatological approach – use of pan evaporimeter – Irrigation scheduling – different approaches-- factor for crop growth stages – critical stages of crop growth for irrigation. Methods of irrigation – surface and sub-surface, pressurized methods viz., sprinkler and drip irrigation, their suitability, merits and limitations, fertigation, economic use of irrigation water, layout of different irrigation systems, drip, sprinkler. Layout of underground pipeline system. Water management problems, quality of irrigation water, irrigation management practices for different soils and crops.

Practical

Measurements of irrigation water by using water measuring devices, use of common formula in irrigation practices, practicing of land leveling and land shaping implements, layout for different methods of irrigation. Estimation of soil moisture constants and soil moisture by using different methods and instruments, scheduling of irrigation and different approaches, practicing use of instruments, estimation of irrigation efficiency and water requirements of horticultural crops, soil moisture conservation practices.

Suggested Readings:

Michael, A.M. 2015. *Irrigation Theory and practices*. Vikas publishing house Pvt., Ltd.

Dilip Kumar Mujmdar. 2004. *Irrigation water management: Principles and Practices*. Prentice Hall of India Pvt. Ltd.,

Rao, Y.P. and Bhaskar, S.R. 2008. *Irrigation technology. Theory and practice*. Agrotech publishing Academy, Udaipur.

S.V. Patil & Rajakumar, G. R., 2016. *Water Management in Agriculture and Horticultural Crops*. Satish serial publishing House, Delhi.

Carr M. K. V. and Elias Fereres. 2012. *Advances in Irrigation Agronomy*. Cambridge University Press.

NRM-211 Environmental Studies and Disaster Management 3(2+1)

Theory

Multidisciplinary nature of environmental studies: Definition, scope and importance. Natural Resources: Renewable and non-renewable resources. Natural resources and associated problems. a) Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forest and tribal people. b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems. c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies. d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies. e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Equitable use of resources for sustainable lifestyles. Ecosystems, Concept of an 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, characteristic features, structure and function of the following ecosystem:- a. Forest ecosystem, b. Grassland ecosystem, c. Desert ecosystem d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries). Biodiversity and its conservation:- Introduction, definition, genetic, species & ecosystem diversity and biogeographical classification of India. Value of biodiversity - consumptive use, productive use, social, ethical, aesthetic and option values. 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. Environmental Pollution: definition, cause, effects and control measures of - Air, Water, Soil, Marine, Noise and 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. Social Issues and the Environment: From Unsustainable to Sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Environmental ethics: Issues and possible solutions, climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust dies. Wasteland reclamation, Consumerism and waste products, Environment Protection Act, Air, Water, Wildlife and Forest Conservation Acts, Issues involved in enforcement of environmental legislation and Public awareness. 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. Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion. Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, road accidents, rail accidents, air accidents, sea accidents. Disaster

Management- Effect to migrate natural disaster at national and global levels. International strategy for disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, community –based organizations and media. Central, state, district and local administration; Armed forces in disaster response; Disaster response; Police and other organizations.

Practical

Visit to local areas - river/forest/ grassland/catchment etc. to document components of ecosystem. Study of common plants, insects, birds and animals. Visit to industries to study pollution abatement techniques and case studies - solid waste management, Human population and the Environment.

Suggested Readings:

A. Nandini, N. Suneetha and Sucharitha Tandon. *Environmental Studies*.

Aswathanarayana, U. 1999. *Soil resources and the environment*. Oxford and IBH publishing Co., New Delhi. P. 173-195.

D. D. Misra. *Fundamental Concepts in Environmental Studies*.

Diwan, P. and P. Diwan. 1998. *Environmental Management Law and Administration*. Variety Books International, New Delhi.

Krishnamurthy. *An Advanced Textbook on Biodiversity*.

S. Deshwal A. Deshwal. *A Basic Course in Environmental Science.*

Erach Bharucha 2005.Textbook of environmental studies for under graduate courses.UGC, University press, Hyderabad.

Manohara Chary and Jayaram Reddy 2004.Principles of Environmental studies BB publishers, Hyderabad.

William, P. Cunning Ham and Mary Ann. Inquiry and applications Cunningham 2005.Principles of Environmental science. Tata MCG raw-hill publishing company limited, New Delhi.

Gupta, P.K. 2004 Methods in environmental analysis-water, soil and Air. Agro Bios (India). Jodhpur.

Spencer R. Weart. The discovery of global warming.

Daniel B. Botkin, Edward A. Keller. Environmental Science.

Richard T. Wright and Bernard J. Nebel Environmental science: toward a sustainable agriculture.

Linfield C. Brown. Pollution prevention and control.

NRM-212 Forest Survey & Engineering 3 (2+1)

Theory

Surveying and methods of surveying, Scope of forest survey, chain surveying, types and instruments used; Traversing, triangulation, survey stations, base line, check and tie lines; ranging of survey lines; offsets and their types; chaining on sloppy grounds, chaining across obstacles; cross staff surveying, Areas of irregularly bounded fields- different methods; Simpson's, trapezoidal rule; prismatic compass, compass surveying, chain and compass traversing, magnetic and true bearing, local attraction. Computation of interior angles and

balancing of closed traverse. Plane table surveying; plane table and its accessories, methods of plane table surveying. Leveling: terms used and types of level. Theodolite and its uses. Contour surveying buildings materials- types, strength and characteristics, site selection for building construction, forest roads- alignment, construction and drainage; retaining walls, breast wall, water ways and culverts; bridges-types, selection of site, simple wooden beam bridge, check dams, spurs, farm ponds, earth dams.

Practical

Chain surveying, compass traversing; plane table surveying, leveling, calculations of earth work for construction of forest roads & earth dams; alignment of forest roads; preparation building plans; design of water ways; design of simple wooden beam bridge; design of retaining walls. Design of check dams.

Suggested readings:

Kanetkar, T.P. and Kulkarni, S.V. (1989). Surveying and levelling. Vidyarthi Griha Prakashan, Pune.
Masani, N.J. (2006). Forest Engineering -without tears (2nd edition). Natraj Publishers, Dehra Dun.
Murthy, V.V.N. (1985). Land and water management engineering. Kalyani Publishers, New Delhi.
Parkash, R. (1983). Forest Surveying, International Book Distributor
Punnia, B.G. (1987). Surveying Vol I. Laxmi Publishers, New Delhi.
Sahani, P.B. (1979). Text Book of Surveying Vol. I & II. Oxford and IBH, New Delhi.

NRM-213 Forest Soils- Biology & Fertility 3 (2+1)

Theory

Introduction - forest soils vs. cultivated soils, special features of forest soils, forest soil formation and vegetation development. Pedogenic processes – Podzolization and Laterization. Properties of soils under different forest ecosystems. Forest floor – stratification – types of humus. Essential nutrient elements-occurrence, availability and their functions. Diagnosis of nutrient deficiencies-visual symptoms, soil fertility evaluation methods. Site productivity and nutrient cycling in forest soils. N, P and K, macro and micronutrient fertilizers and their uses. Forest soil - biology-distribution of various microorganisms in soil ecosystem and their interaction effects. Role of microorganisms in soil fertility. Mineral transformations-carbon cycle with reference to organic matter decomposition and humus formation, Microbial degradation of cellulose & lignin. Bio-fertilizers – their importance. Nitrogen fixation-Rhizobium-tree legume symbiosis, Frankia X non-legume symbiosis, asymbiotic and associative N2 fixation. Nitrification and denitrification in forest ecosystems. Microbial transformation of phosphorous, sulphur, and micronutrients. Mycorrhizae: types, biology and importance with specific relevance to tree crops and mobilization of phosphorus and micro-nutrients. Rhizosphere and phyllosphere concept. Fertility management of forest soils. Integrated nutrient management in plantation forestry.

Practical

Study of forest soil profile; Estimation of pH and EC –Organic carbon – available N, P, K, Ca, Mg, S and micronutrients – Determination of CEC and exchangeable cations; Interpretation of soil and plant analysis data for fertilizer recommendation. Basic sterilization techniques; culturing and maintenance of micro organism occurring in soil; Staining methods; Study of decomposition of forest litter by CO_2 – evolution method; Estimation of nitrification rate in soil;

Isolation of legume bacteria and Azotobacter; Preparation and inoculation techniques for mycorrhizae and biofertilizers.

Suggested readings:

Brady, NC. The Nature and Properties of Soils. Mac Millan Pub. Comp. New York.

Burges, A. and Raw, F. 1967. Soil Biology. Acad. Press, New York

Mengel, K. and Kirkby, A. 1978. Principles of Plant Nutrition. International Potash Institute, Switzerland

Pritchett and Fisher RF 1987. Properties and Management of Forest Soils. John Wiley, New York.

Mani, A.K.; Santhi, R. and Sellamuthu, K. M. 2008. Fundamentals of Forest soils. Satish Serial Publishing House, New Delhi.

Tisdale, L. S. Nelson, L.W. and Beaton, J. D. 1985. Soil Fertility and Fertilisers. Macmillan Publishing Company, New York

Young, A. 1989. Agroforestry for Soil Conservation. CAB International, U.K.

Wilde, S. A.(1984) Forest Soils and Forest Growth. Periodical Experts Book Agency, New Delhi.

Negi, S. S. (2000) Forest Soils. International Book Distributors, Dehradoon (UK).

NRM-221 Soil, Water and Plant Analysis 2(1+1)

Theory

Methods of soil, **water** and plant sampling and processing for analysis. Characterization of hydraulic mobility – diffusion and mass flow. Renewal of gases in soil and their abundance. Methods of estimation of oxygen diffusion rate and redox potential. Use of radio tracer techniques in soil fertility evaluation. Soil micro-organisms and their importance. Chemical and mineral composition of horticultural crops. Leaf analysis standards, index tissue, interpretation of leaf analysis values. Rapid tissue tests for soil and plant. Quality of irrigation water. Soil and Water pollution. Management of poor quality irrigation water in crop management.

Practical

Introduction to analytical chemistry, Collection and preparation of soil, water and plant samples for analysis. Determination of pH, electrical conductivity, sodium adsorption ratio and exchangeable sodium percentage of soils. Estimation of available macro and micronutrient elements in soils and their contents in plants. Irrigation water quality analysis. Determination of pH and EC in irrigation water samples, Determination of Carbonates and bicarbonates in soil and irrigation water, Determination of Calcium and Magnesium in soil and irrigation water. Determination of N, P, K, Ca, Mg, S and micronutrients in plant samples. Determination of Sodium, Potassium, Chlorine and Boron in irrigation water.

Suggested Readings:

H.L.S. Tandon. 2013, *Methods of analysis of soil, plant, water and fertilizers*. FDCO, New Delhi.

Yawalkar, K.S. Agarwal, J.P. and Bokde, S., 1977. *Manures and Fertilizers*. Agri-Horticultural Publishing House, Nagpur.

Sehgal J. A., 2005. *Textbook of Pedology Concepts and Applications*. Kalyani Publishers, New Delhi.

Jaiswal, P.C., 2006. *Soil, Plant and Water Analysis* (2nd Edition), Kalyani Publishers, Ludhiana.

Jackson M. L, 1967. *Soil Chemical Analysis*, Oxford and IBH Publishing Co., New Delhi.

Richards L A, 1968. *Diagnosis and Improvement of Saline and Alkaline Soils*. Oxford and IBH publishing Co. New Delhi(USDA Hand Book No. 60)

Chopra S.C. and Kanwar, J. S 1976. *Analytical Agricultural Chemistry*, Kalyani Publishers, Ludhiana.

C. S. Piper. 2014, *Soil and plant analysis*, Scientific publishers India.

Mushtaq A. Wan., 2014, *Soil, plant and water analysis manual*. Agrotech publishing company, Udaipur.

P. K. Gupta., 2013, *Soil, plant, water and fertilizer analysis*. Agrobios, India.

M. V. Durai., 2014, *Hand book of Soil, plant, water, fertilizers and manure analysis*. New India publishing agency.

NRM-222 Farm Power and Machinery 2(1+1)

Theory

Basic concepts of various forms of energy, unit and dimensions of force energy and power, calculations with realistic examples. IC Engines: Basic principles **and** operation of compression, ignition and spark ignition engines, two stroke and four stroke engines, cooling and lubrication system, power transmission system of tractors, power tillers and their types and uses. Electric motors: types, construction and performance comparison. Tillage: objectives, method of ploughing. Primary tillage implements: construction and function of indigenous ploughs, improved indigenous ploughs, mould board ploughs, disc and rotary ploughs. Secondary tillage implements: construction and function of tillers, harrows, levelers, ridgers and bund formers. Sowing and transplanting equipment: seed drills, potato planters, seedling transplanter. Inter-culture equipment: sweep. Junior hoe, weeders, long handle weeders. Crop harvesting equipments: potato diggers, fruit pluckers, tapioca puller and hoists.

Practical

Calculation on force, power and energy. IC engines – showing the components of dismantled engines and motors. Primary and secondary tillage implements, hitching, adjustments and operations. Spraying equipment, calibration and operation. Plant protection equipment.

Suggested readings:

T. P. Ojha and A.M. Michael. 2005. *Principles of Agricultural Engineering* (Volume - 1), Jain Brothers

Manoj Kumar Ghoshal and Dhirendra Kumar Das. 2008. *Farm Power*, Kalyani Publishers.

Surendra Singh. 2007. *Farm Machinery Principles and Applications*. ICAR Publications

Roth / Field. 1992. *Introduction to Agricultural Engineering - Problem Solving Approaches,* 2nd. Edition. CBS publishers & distributors Pvt. Ltd.

Surendra Singh & Verma. 2009. *Farm Machinery Maintenance & Management*. ICAR Publication.

M.M. Pandey & Others. 2012. *Handbook of Agricultural Engineering*. ICAR publication

Jagadishwar Sahay. 1992. *Elements of Agricultural Engineering*. Agro Book Agency, Patna.

Michal AM and Ojha TP. 1993.*Vol I. Principles of Agricultural Engineering.* Jain Brothers, New Delhi.

Kepner RA Roy Bainer and Barger BL. 1978. *Principles of Farm Machinery*. CBS Publisher and Distributors, Delhi.

Jain S C. 2003.*Farm Machinery - An approach.* Standard Publishers and Distributors, New Delhi

Nakra, C.P. 1986. *Farm Machinery and Equipment*. Dhanpat Rai and Sons, New Delhi

Klenin, N.I. Popov, I.F. and Sakun, V.A. 1985. *Agricultural Machines*. Amerind publishing Co. Pvt. Ltd., New Delhi.

NRM-311 Introduction to Major Field Crops 2(1+1)

Theroy

Classification and distribution of field crops, definitions and concept of multiple cropping, mixed cropping, intercropping, relay and alley cropping, cultural practices for raising major cereals, pulses, oil seeds and fodder crops, green manuring, crop rotation.

Practical

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

Suggested Reading:

B. Gurarajan, R.Balasubramanian and V.Swaminathan. Recent Strategies on Crop Production. Kalyani Publishers, New Delhi.

Chidda Singh.1997. Modern techniques of raising field crops. Oxford and IBH

Publishing Co. Pvt. Ltd., New Delhi.

Rajendra Prasad. Textbook of Field Crops Production - Commercial Crops. Volume II ICAR Publication.

Rajendra Prasad. Textbook of Field Crops Production - Foodgrain Crops. Volume I ICAR Publication.

S.R.Reddy. 2009. Agronomy of Field Crops. Kalyani Publishers, New Delhi.

S.S.Singh. 2005. Crop Management. Kalyani Publishers, New Delhi.

UAS, Bangalore. 2011. Package of Practice. UAS, Bangalore.

Chidda Singh 1983. Modern Techniques of raising Field crops.Oxford & IBH, Publishing Co., New Delhi

Rajendra Prasad 2002. Text Book of Field crops Production,ICAR, New Delhi.

Reddy, S.R. 2004. Agronomy of Field crops, Kalyani Publishers, Ludhiana.

Subhash Chandra Bose, M. and Balakrishnan, V. 2001. Forage Production South

Asian Publishers, New Delhi.

NRM-312 Introductory Agro-forestry 2(1+1)

Theory

Agroforestry – definition, objectives and potential. Distinction between agroforestry and social forestry. Status of Indian forests and role in Indian farming systems. Agroforestry system, sub-system and practice: agri-silviculture, silvipastoral, horti-silviculture, horti-silvipastoral, shifting cultivation, taungya, home gardens, alley cropping, intercropping, wind breaks, shelterbelts and

energy plantations. Planning for agroforestry – constraints, diagnosis and design methodology, and selection of tree crop species for agro-forestry. Agroforestry projects – national, overseas, MPTS – their management practices, economics of cultivation – nursery and planting (*Acacia catechu*, *Dalbergia sissoo*, Tectona, Populus, Morus, Grewia, Eucalyptus, *Moringa olefera, Murraya koengii* , Quercus spp. and bamboo, tamarind, neem etc.

Practical

Identification and seeds and seedlings of multipurpose tree species. Nursery practices for, *Acacia catechu*, *Dalbergia sissoo*, leucaena, *Ailanthus excelsa, Pongamia pinnata, Acacia nilotica, khejri, tamarind, neem bamboo* etc. Visit to agro-forestry fields to study the compatibility of MPTS with agricultural crops: silvipastoral, alley cropping, horti-silviculture, agro-silvipasture, fuel and fodder blocks. Visit to social forestry plantations – railway line plantations, canal plantations, roadside plantations, industrial plantations and shelterbelts. Rapid assessment of farmers needs for green manure, fodder, fuel wood in selected villages. Economics and marketing of products raised in agro-forestry systems

NRM-313 Agro-meteorology and Climate Change 2(1+1)

Theory

Agricultural Meteorology- Introduction, definition of meteorology, scope and practical utility of Agricultural meteorology. Composition and structure of atmosphere and definition of weather and climate, aspects involved in weather and climate, atmospheric temperature, soil temperature, solar radiation, atmospheric pressure, atmospheric humidity, evaporation and transpiration, monsoons, rainfall, clouds, drought, weather disasters and their management atmospheric pollution and role of meteorology. Basics of weather forecasting. Climate change-causes. Global warming-causes and remote sensing. Effect of climate change on horticulture Past and future changes in greenhouse gases within the atmosphere. Sources and sinks for greenhouse gases. Atmospheric chemistry. Plants sense and respond to changes in CO_2 concentration. Measurement of short-term effects and mechanisms underlying the observed responses in C_3 and C_4 species. Plant development affected by growth in elevated CO_2. Physiology of rising CO_2 on nitrogen use and soil fertility, its implication for production. Methodology for studying effect of CO_2. Change in secondary metabolites and pest disease reaction of plants. The mechanisms of ozone and UV damage and tolerance in plants. Increased temperature and plants in tropical/sub-tropical climates- effect on growing season, timing of flowering, duration of fruit development and impacts on crop yields and potential species ranges, interaction of temperature with other abiotic/biotic stress. Mitigation strategies and prospects for genetic manipulation of crops to maximize production in the future atmosphere. Modifying Rubisco, acclimation, metabolism of oxidizing radicals, and sink capacity as potential strategies.

Practical

Site selection for Agromet observatory; Measurement of temperature; Measurement of rainfall; Measurement of evaporation (atmospheric/soil); Measurement of atmospheric pressure; Measurement of sunshine duration and solar radiation; Measurement of wind direction and

speed and relative humidity; Study of weather forecasting and synoptic charts. Visit to Meteorological observatory, Visit to IMD meteorological observatory-Lay out plan of standard meteorological observatory. Recording of air and soil temperature. Measurement of radiation and components, Measurement of rainfall-different types of raingauges, Measurement of wind speed and direction and atmospheric humidity, Recording of evaporation. Synoptic charts and weather reports, symbols, etc.

NRM-314 Forest Hydrology and Watershed Management 3 (2+1)

Theory

Importance and scope of Hydrology. Definftions. Hydrological cycle. Energy and water balance equationsprecipitation- rain and snow hydrology. Interception, infiltration, evaporation and transpiration- paired water sheds, surface water, run off processes and hydrograph. Soil water energy concept, movement, availability and measurement. Watershed management- an approach for sustainable productivity-principles and practices- Methods for water conservation- water harvesting techniques. Role of trees in water conservation- natural terracing- species suitability- Recharging of water springs. Forest treatment and water yield. Application of GIS in watershed delineation.

Practical

Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Visit to forest watersheds to study the effect of forest treatment on hydrological properties. Assessemnt of the impact of watershed treatments such as afforestation/restocking, assisted regeneration etc. on the watershed functioning- field layout- regeneration assessment- interpretation of results.

Suggested reading

Bennet, H. H. 1965. Elements of Soil conservation. Mc Graw Hill Book Co. Inc. New York

Dhruva Narayana V. V. 1993. Soil and Water Conservation Research in India, ICAR, New Delhi

Dhruva Narayana V. V., G. Sastry and U. S. Patnaik. 1997. Watershed Management. Indian Council of Agricultural Research, New Delhi, 176 p

Gurmail Singh et al., 1988. Manual of Soil and Water Conservation. Oxford IBH Publishing Co. New Delhi

Hamilton L. S. 1983. Tropical Forested Watersheds: hydrologic and soils response to major uses or conversions. International Book Distributors, Dehra Dun

Hamilton, L.S. (ed.). 1983. Forest and Watershed Development snd Conservation in Asia and the Pacific. International Book Distributors, Dehra Dun

Hewlett, JD and Nutter, WL 1969. An Outline of Forest Hydrology. University of Georgia Press, Athens 132p

Hudson, N. 1981. Soil Conservation. BT Batsford Limited, London 324 p.

Lal R. 2000. Integrated Watershed Management in the Global Ecosystem. CRC Press, London

Michael, A.M. 2008. Irrigation theory and practice, Vikas Publishing House Pvt Ltd. 768p

Morgan, R.P.C. 1988. Soil Erosion and Conservation. English Language Book Society, Longman, London
Murthy, V.N.N. 1983. Land and Water Management Engineering, Kalyani Publishers, New Delhi.
Rama Rao, M.S.V. 1962. Soil Conservation in India, ICAR, New Delhi
Riedl, O. and Zachar, D. 1984. Forest Amelioration. Elsevier, Amsterdam
Satterlund, DR. 1972. WildlandWatershed Management. The Ronald Press Company, New York
Seshagiri Rao, K. V. 2000. Watersheds, Comprehensive Development. B. S. Publications, Hyderabad
USDA 1961. A Manual on Conservation of Soil and Water. Oxford and IBH Publishing Company

NRM-321 Organic Farming 2 (1+1)

Theory

Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, 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 **procedures**, marketing, exports.

Practical

Raising of vegetable crops organically through nutrient, diseases and pest management; vermicomposting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, postharvest management.

Suggested Readings:

A.K.Dahama. 2007. *Organic farming for sustainable agriculture*. Agrobios (India), Jodhpur.
Arun. K. Sharma. 2011. *Handbook of Organic farming*. Agrobios (India), Jodhpur.
S.P. Palaniappan and K.Annadurai. 2010. *Organic farming – Theory and Practice*. Scientific Publishers. Jodhpur.
U.Thapa and P. Tripathy. 2006. *Organic farming in India- Problems and Prospects*. Agrotech publishing agency, Udaipur.
G.K.Veeresh. 2006. *Organic farming*. Foundation Books. New Delhi.
Purshit, S.S. 2006. *Trends in Organic Farming in India*. Agros Bios (INDIA), Jodhpur.
Thampan, P. K. 1995. *Organic Agriculture*. Peckay tree Crops Development Foundation, Cochin, Kerala.
Sathe, T.V. 2004. *Vermiculture and Organic Farming*. Days Publishing House, New Delhi.

NRM-322 Geomatics 3 (1+2)

Theory

Remote sensing - classification based on source: Active and passive remote sensing; Aerial and space remote sensing; Interaction of electromagnetic radiation with atmosphere and earth surface; Aerial photographs – types; Photo interpretation - Satellite remote sensing - platforms and sensors; Satellite systems. Indian Remote Sensing Programme; Visual and digital image processing; Application of satellite based remote sensing techniques in forestry - vegetation mapping using satellite imagery-NDVI; Forest cover monitoring and damage assessment; Microwave remote sensing. Introduction to GIS. Differences between GIS and conventional cartography. Spatial and non-spatial data- Integration of attribute data with spatial data. Spatial data - Raster and Vector data-Thematic over lays in GIS- topology building and calculation of area and length etc. Application of GIS in forestry – using imageries and integration with GIS data. Maps-its projection-Toposheet and Map reading. Global Positioning System (GPS) applications in resource inventory, Global Navigation Satellite System, Galileo, GLONASS, QZSS, Compass, IRNSS etc., GAGAN

Practical

Preparation maps; Visual interpretation of satellite imagery; Forest cover mapping and land use mapping. Digital image processing. Introduction to various GIS software – Q-GIS, ERDAS, Arc GIS etc. Exercises in viewing, editing, overlay. Visit to the GIS labs at State level.

Suggested reading

Campbell, J.B. (2002). Introduction to Remote Sensing-Third edition. Taylor and Francis, London

Environment System Research Institute, (1999). GIS for Everyone. Redlands, CA:ESRI

Jackson, M.J. (1992). Integrated Geographical Information Systems. International Journal of Remote Sensing, 13(6-7): 1343-1351

Joseph, G. (2005). Fundamentals of Remote Sensing-Second edition. Universities Press

Lillesand, T.M. and Kiefer,W.R.(1994).Remote sensing and Image Interpretation, Fourth edition. John Wiley & Sons, Inc., USA

Obi Reddy, G.P. and Sarkar, D. (2012). RS and GIS in Digital Terrain Analysis and Soil Landscape Modelling. NBSS & LUP, Nagpur.

BAS-111 Elementary Statistics and Computer Application 3(2+1)

Theory

Introduction to statistics, limitations of statistics. Basic concepts: Variables Statistics, types and sources of data, classification and tabulation of data, construction of frequency distribution, tables, graphic representation of data, simple, multiple component and percentage bar diagram, pie diagram, histogram, frequency polygon and frequency curve average and measures of location, mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles, for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Random experiments, event, mathematical probability, statistical probability, Basic concept, additive and multiplicative laws. Theoretical distributions, binominal, poison and normal distributions. Sampling: basic concepts, sampling vs. complete

enumeration parameter and statistic, sampling methods, simple random sampling and stratified random sampling. Tests of Significance: Basic concepts, tests for equality of means, and independent and paired t-tests. Chi-square test for application of attributes and test for goodness of fit of Mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties, regression, fitting of simple linear regression, test of significance of correlation and regression coefficient. Experimental designs: Principles of design of experiments, Basic concepts: completely randomized design, randomized block design, latin square designs, factorial experiments. Basic concepts: Analysis of factorial experiments up to 3 factors, split plot design, strip plot design, long term experiments, plot size. Computer application: Introduction to computers and personal computers, basic concepts, operating system, Windows, MS Word-Features of word processing, creating document and tables and printing of document, MS Excel-Concept of electronic spreadsheet, creating, editing and saving of spreadsheet, inbuilt statistical functions and formula bar, MS Power point-preparation, presentation of slides and slide show. Introduction to multi-media and its application. Introduction to internet, use, application.

Practical

Construction of frequency distribution table and its graphical representation, histogram, frequency polygon, frequency curve, bar chart, simple, multiple, component and percentage bar charts, pie chart. Mean, mode, median for row and grouped data. Problem based on Range, standard deviation, variance, coefficient of variation for raw and grouped data coefficient of variation, Examples of 't' test for independent, paired 't' test, Chi-square test for contingency tables and theoretical ratios. Correlation and linear regression. Studies on computer components MS Office: World, Excel, power point, Internet.

Suggested Reading:

Gupta, S. C. and Kapoor, V. K. 2014. Fundamentals of Mathematical Statistics. Sultan chand and sons. New Delhi

Nageswara Rao, G. 2007. *Statistics for Agricultural Sciences*. B S Publications, Hyderabad.

Rangaswamy, R. 1995. *A Text Book of Agricultural Statistics*. New Age International Publishing Limited, Hyderabad.

Gupta, V., 2002. *Comdex Computer Kit*. Dream Tech Press, New Delhi.

Parmar, A. Mathur, N. Deepti P. U. and Prasanna, V. B., 2000. *Working with WINDOWS A Hands on Tutorials*. Tata McGraw Hill Publishing Co., New Delhi.

Bandari, V. B., 2012. *Fundamentals of Information Technology*. Pearson Education,New Delhi.

Fundamentals of Computers. 2011. Pearson Education-ITL ESL, New Delhi,

BAS-112 Economics and Marketing 3(2+1)

Theroy

Nature and scope of economics, definition and concepts, divisions of economics, economic systems, Consumption – theory of consumer behaviour, laws of consumption, classification of goods. Wants – their characteristics and classification, utility and its measurement, cardinal and ordinal, law of diminishing marginal utility, law of equi-marginal utility, indifference curve and its properties, consumer equilibrium. Theory of demand, demand schedule and curve, market demand. Price, income and cross elasticities, Engil's law of family expenditure – consumer's surplus. Theory of firm, factors of production – land and its characteristics, labour and division of labour, theories of population. Capital and its characteristics – classification and capital formation. Enterprises – forms of business organization – merits and demerits. Laws of return – law of diminishing marginal return – cost concepts. Law of supply – supply schedule and curve elasticities. Market equilibrium, distribution – theories of rent, wage, interest and profit. Price determination and forecasting under various market structures. Marketing- definition – Marketing Process – Need for marketing – Role of marketing — Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Case studies of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets. Estimation of demand and supply of horticulture produce.

Suggested Reading

H L Ahuja. S. Chand and Company Limited. *Advanced Economic Theory*. Micro Economic Analysis.

Chandra P. 1984. *Projects: Preparation, Appraisal & Implementation*. McGraw Hill Inc.

Dewett, K.K. and Chand, A.1979. *Modern Economic Theory*. S.Chand and Co., New Delhi

Dewett, K.K. and Varma, J.D. 1986. Elementary Economics. S.Chand and Co., New Delhi.

Gupta RD & Lekhi RK. 1982. Elementary Economic Theory. Kalyani Publishers.

Jhingan, M.L. 2012. Macro Economic Theory. Vrinda publishers, New Delhi .

Kotler Philip and Armstrong. Principles of Marketing. Prentice-Hall.

SS Acharya and N L Agarwal. 2005. Agricultural Marketing in India. Oxford and IBH Publishing Co. Pvt. Ltd

Sampat Mukherjee. 2002. *Modern Economic Theory*. New Age International.

Subba Reddy, S., Raghu ram, P., Neelakanta Sastry T.V., Bhavani Devi. I., 2010, *Agricultural Economics*, Oxford & IBH Publishing Co. Private Limited, New Delhi

Willium J. Stanton. 1984. *Fundamentals of Marketing*. Tata McGraw-Hill Publication, New Delhi.

C.N. Sontakki. Marketing Management. Kalyani Publishers, New Delhi.

John Daniels, Lee Radebaugh, Brigham, Daniel Sullivan. International Business, 15th Ed., Pearson Education

Aswathappa. International Business. Tata McGraw-Hill Education, New Delhi

Fransis Cherunilam. International Business: Text and Cases, 5th Ed. PHI Learning, New Delhi.
Prasanna Chandra. Projects. Tata McGraw-Hill Pu blication, New Delhi
John M. Nicholas. *Project Management for Business and Technology* – Principles and Practices. Pearson Prentice Hall
Harold Kerzner. Project Management – A System Approach to Planning, Scheduling, *and Controlling.* CBS Publishers & Distributors.
Prasanna Chandra. *Projects – Planning, Analysis, Selection, Financing, Implementation, and Review.* Tata McGraw-Hill Publishing Company Ltd.
P. Gopalakrishnan and V.E. Rama Moorthy. *Textbook of Project Management*. Macmillan.

BAS-113 Elementary Plant Biotechnology 2(1+1)

Theroy

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; Somatic embryogenesis and synthetic seed production technology. Protoplast isolation, Culture, and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer, Gene cloning, Direct and indirect method of gene transfer. Transgenic plants and their applications. Blotting techniques, DNA finger printing, DNA based markers: RFLP, AFLP, RAPD, SSR and DNA Probes, Mapping QTL: Future prospects. MAS, and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoricsis techniques. Green synthesis of nano particles and their size characterization.

Suggested Reading:

Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.
Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co., Meerut.

Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, inc. USA.
Gautam V K, 2005. *Agricultural Biotechnology*. Sublime Publications
Thomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. *Molecular markers and Plant biotechnology*, New Publishers, New Delhi.
Purohit, S.S., 2004. *A Laboratory Manual of Plant Biotechnology* 2nd Edn. Agribios, India.
Singh, B.D. 2012. *Plant biotechnology*. Kalyani publishers, Ludhiana
Bilgrami, K.S. and Pandey, A.K.1992. *Introduction to biotechnology*. CBS Pub. New Delhi
Gupta, P.K. 1994. *Elements of biotechnology*. Rastogi Pub. Meerut.
Chahal, G.S. and Gosal, S.S.2003. *Principles and procedures of plant approaches breeding Biotechnological and conventional*. Narosa Publishing House, New Delhi

BAS-114 Introductory Crop Physiology 2(1+1)

Theroy

Water Relations in Plants: Role of water in plant metabolism, osmosis imbibition, diffusion, water potential and its components, measurement of water potential in plants, absorption of water, mechanism of absorption and ascent of sap. Stomata: Structure, distribution, classification, mechanism of opening and closing of stomata. Osmotic pressure, guttation, stem bleeding; transpiration methods, mechanism and factors affecting transpiration. Drought: Different types of stresses; water, heat and cold tolerance; mechanism of tolerance. Plant Nutrition: Essentiality, mechanism of absorption and its role in plant metabolism. Biological Nitrogen Fixation Photosynthesis, structure and function of chloroplast, dark and light reactions, cyclic and non-cyclic electron transfer, CO_2 fixation – C3, C4 and CA metabolism, advantages of C4 pathway. Photorespiration and its implications, factors affecting photosynthesis. Secondary metabolites and plant defense.

Practical

Measurement of water potential, osmosis, root pressure, structure of the stomata, distribution, opening and closing of the stomata, measurement, transpiration and calculation of transpirational pull demonstration. Importance of light and chlorophyll in photosynthesis, pigment identification in horticultural crops, measurement of relative water content (RWC), studying plant movements.

Suggested Reading:

Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.
Taiz, L. 2010.Plant Physiology. SINAUR. USA.
Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.
Edward E. Durna. 2014. Principles Of Horticultural Physiology. CABI, UK.
Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.
Richard, N. Arteca. 2004. Plant Growth Substances. CBS. New Delhi.
Jacobs, W. P. 1979. Plant Hormones And Plant Development. Cambridge Univ. London.
Basra, A. S. 2004. Plant Growth Regulators in Agriculture & Horticulture. HAWARTH press. New York.

Lincoln Taiz and Eduards Zeiger (5th Edition). Plant physiology
Noggle G.R and Fritz T.G. Introductory Plant Physiology
Pandey and Sinha. Plant Physiology
Salisbury and Ross. Plant Physiology
Carl fedtke. Biochemistry and Physiology of Herbicide Action
Aswani pareek, S.K. Sopory, Hans Bohnert Govindjee. Abiotic stress adaptation in plants: Physiological, Molecular and Genomic foundation
Horst Marschner, Mineral Nutrition of Higher plants

BAS-115 Introductory Microbiology 2(1+1)

Theroy

History and Scope of Microbiology: The discovery of micro-organism, spontaneous generation conflict, germ theory of diseases, microbial effect on organic and inorganic matter. Development of microbiology in India and composition of microbial world. Microscopy and Specimen Preparation: The bright field microscope, fixation, and simple staining, differential staining. Difference between prokaryotic and eukaryotic cells. Prokaryotic cell structure and functions. Types of culture media and pre-culture techniques. Microbial growth in models of bacterial, Yeast and mycelia growth curve. Measurement of bacterial growth. General properties of viruses and brief description of bacteriophages. DNA as genetic material. Antibiosis, symbiosis, intra-microbial and extra-microbial association. Sterilization methods – Physical and chemical, Isolation of pure cultures and preservation of cultures. Plant growth promoting microorganisms and mushrooms – Economical importance, Industrially important microorganisms in large scale production and common microbial fermentations. Mushrooms-edible and poisonous types, nutritive values, Culturing and production techniques.

Practical

Examination of natural infusion and living bacteria; examination of stained cells by simple staining and Gram staining. Methods for sterilization and nutrient agar preparation. Broth culture, agar slopes, streak plates and pour plats, turbid metric estimation of microbial growth, mushroom culture- Spawn production, Culture and production techniques, harvesting, packing and storage.

Suggested Reading:

M T Madigan, and J M Martinko, 2014. *Brock Biology of Microorganisms* 14th Edn. Pearson.
M J Pelczer, 1998. *Microbiology* 5th Edn. Tata McGrow Hill Education Pvt. Ltd.
Stainer, R, 1987. *General Microbiology*. Palgrave Macmillan.
Edward Alchano, 2002. *Introduction to Microbiology.* Jones and Bartlett hearing.
R P Singh, 2007. *General Microbiology*. Kalyani Publishers.
J Heritage, E G V Evans, R A Killington, 2008. *Introductory Microbiology*. Cambridge University press P. date.

Pelczar, jr. M.J.E.C.S.Chan and Krieg, N.R. 1996. *Microbiology*. Mc Graw Hill Publishers, Newyork.

Prescott, L.M. Harley, J.P. and Klein, D.A (5ed) 2002. *Microbiology*. Mc Graw Hill Publishers, Newyork.

Madigan, M. Martinkoj, M. and Parker (10 ed.) 2003. *Biology of Microorganisms*. Prentice Hall of India Pvt. Ltd., New Delhi.

Jamaluddin, M. Malvidya, N. and Sharma, A. 2006. *General Microbiology*. Scientific Publishers, Washington.

BAS-116 Communication Skills and Personality Development 2(1+1)

Theroy

Structural Grammar: Introduction of Word Classes; Structure of Verb in English; Uses of Tenses; Study of Voice; Study of Conjunctions and Prepositions; Sentence Patterns in English. Spoken English: Conversations of different situations in everyday life; the concept of stress; stress shift in words and sentences; silent letters in words and pronunciation of words with silent letters, the basic intonation patterns. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; individual and group presentations, imprompt presentation, public speaking; Group discussion. Organizing seminars and conferences.

Practical

Structural Grammar: Exercises in word classes, identification and study of verbs in sentences, application of tenses and voice, exercises in conjunctions and prepositions, other structural grammar exercises, report writing, letter writing (different types of letters). Spoken English: Conversations of everyday life, the concept of stress; stress shift. Silent letters in words, basic intonation patterns, preparing and address.

Suggested Reading:

Balasubramanian T. 1989. *A Text book of Phonetics for Indian Students*. Orient Longman, New Delhi.

Balasubrmanyam M. 1985. *Business Communication*. Vani Educational Books, New Delhi.

Naterop, Jean, B. and Rod Revell. 1997. *Telephoning in English*. Cambridge University Press, Cambridge.

Mohan Krishna and Meera Banerjee. 1990. *Developing Communication Skills*. Macmillan India Ltd. New Delhi.

Krishnaswamy,. N and Sriraman, T. 1995. *Current English for Colleges*. Macmillan India Ltd. Madras.

Narayanaswamy V R. 1979. *Strengthen your writing*. Orient Longman, New Delhi.

Sharma R C and Krishna Mohan. 1978. *Business Correspondence*. Tata Mc Graw Hill publishing Company, New Delhi.

Carnegie, Dale. 2012. *How to Win Friends and Influence People in the Digital Age*. Simon & Schuster.

Covey Stephen R. 1989. *The Seven Habits of Highly Successful People*. Free Press.
Spitzberg B, Barge K & Morreale, Sherwyn P. 2006. *Human Communication: Motivation, Knowledge & Skills*. Wadsworth.
Verma, KC. 2013. *The Art of Communication.* Kalpaz.
Dr. T. Bharati, Dr. M. Hariprasad and Pro. V. Prakasam, Personality Development and Communicative English. Neelkamal Publications Pvt. Ltd, New Delhi.
Wren and Martin, S. Key to High School English Grammar and Composition- Chand and Company Ltd., New Delhi
Wren and Martin, S. High School English Grammar and Composition- Chand and Company Ltd., New Delhi
Raymond Murphy, English Grammar in Use. Cambridge University Press
The Official Guide to the TOEFL Test-IV Edition, Educational Testing Services. Mc Graw Hill, New Delhi.
Balasubramanyam, M. 1985. Business communication. Vani Educational Books Ansari road, New Delhi.
Krishna Mohan and Meera Banerjee 1990. Developing Communication Skills. Macmillan India Ltd.

BAS-117 Forest Botany 2(1+1) NC

Theory

Introduction to Botany; General classification of plants – Phanerogams, Cryptogams, Angiosperms and Gymnosperms, Dicotyledons and Monocotyledons; General body organization and characters of Algae (e.g. *Chlamydomonas*), Fungi (*Mucor*), Bryophytes (*Moss*) and Pteridophytes (*Nephrolepis*); Parts of flowering plants- Root system and Shoot system, typical structure of root, stem and leaf; Functions of root, stem and leaves; Basic Structure of Flower- Essential and Non essential parts of flower; Morphology of root, stem and leaves; Morphology of Flower with emphasis on Inflorescence; Types of Phyllotaxy and Venation in leaves, types of placentation and aestivation in flower; Basic types of tissues (Structure and Function) - Dermal, Vascular and Ground tissues; Parenchyma, Sclerenchyma, Collenchyma, Chlorenchyma, Aerenchyma, Cambium, Xylem and Phloem; Types of vascular bundles in flowering plants.

Practical

Morphology of root, stem and leaves with special emphasis on underground and aerial modifications in root and stem; simple and compound leaves; types of phyllotaxy and venation (live specimens); typical structure of bisexual flower; types of inflorescence (live specimens); types of tissues with the aid of permanently mounted slides; Tissue organization in Dicot root, stem and leaves; Tissue organization in Monocot root, stem and leaves with the aid of permanent slides or study charts.

Suggested reading:

Ashok Bendre and Ashok Kumar. (1984). *Textbook of Practical Botany*. Vol. I and II. Rastogi Publications. Meerut. India. (Also available on Flipkart and Amazonbooks. Com)
Ashok Bendre and P. C. Pande. (1996). *Introductory Botany*. Rastogi Publications. Meerut. India.
Ashok Kumar (2001). *Botany in Forestry and Environment*. Kumar Media (P) Ltd. Gandhinagar, Gujarat.
Dutta. C. (1998). *Botany for Degree Students*. (1998). Oxford University Press. India

Dutta. C. (2000). *Class Book of Botany*. Oxford University Press. India
Gurucharan Singh. (2000). *Plant Systematics*. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
Pandey S. N. and S. P. Mishra. (2008). *Taxonomy of Angiosperms*. Ane Books India, New Delhi.
Pandey. P. (2012). *Taxonomy of Angiosperms*. S. Chand and Company Ltd. New Delhi.

BAS-118 Basic Mathematics 2(2+0)

Elementary idea of complex number. Arithmetic and Geometric progressions. Elementary idea of permutation and combinations. Matrix of a system of linear equations. Binomial theorem for positive integral index, any index and their applications, addition and subtraction formulae. A, B and C, D formulae.

SineandCosineformulae.InverseTrigonometricfunctions,ratiosandtheirinter relationships. Limit of functions-differentiations and integrations simple applications-maxima and minima least square techniques- Introduction to matrices and determinants, special
type of matrices, addition, subtraction and multiplication of matrices.

Suggested Readings

Chatterjee S. K. (1970). Mathematical Analysis. Oxford & IBH.
Frank, A. (1962). Schaum's Outline of Theory and Problems of Matrices. McGraw-Hill
Frank, A. 1967. Theory and Problems of Differential Equations. McGraw-Hill
Gentle JE. (2007). Matrix Algebra: Theory, Computations and Applications in Statistics. Springer
Narayan, S. (1953). A Text Book of Matrices. S. Chand and Company.
Parameswaran, S. (1976). An introduction to mathematics. Oxford & IBH Publishing Co. 172p.
Priestley, H.A. (1985). Introduction to Complex Analysis. Clarenton Press
Walter R. (1976). Principles of Mathematical Analysis. McGraw-Hill.

BAS-119 Physical Education – I 1(0+1)

Practical

Concept of Physical Education - Meaning, need & importance, aim, & objectives. Conditioning exercises - warming up, warming down (general & specific), and flexibility exercise. Physical Fitness exercises for speed, strength, agility, endurance and co ordination. Posture & Concept - Definition, values of good posture, causes & drawbacks of bad posture , Common postoral deviation, their causes and correct exercises, Kyphosis, Scoliosis, Lordosis, Knock knee & Bow legs, Flatfoot. Running ABC'S, walking ABC'S - Major games - Rules and regulations of important games, Skill development in any one of the games- Football, Basketball & Ball badminton. Indoor games - Participation in one of the indoor games - Shuttle badminton & table tennis . Athletic events - Rules & regulations of athletic events, Participation in any of the athletic events – Broad jump, high jump and short put. Conduct of Health Related Physical Fitness Test (TPFP): One mile run/ Beep test, Sit-Up 60sec, Sit and reach, Modified pull-ups. NOTE: (one to be selected major games, indoor games and Athletic events).

BAS-121 Growth and Development of Horticultural Crops 2(1+1)

Theroy

Growth and development-definitions, components, photosynthetic productivity, Canopy photosynthesis and productivity, leaf area index (LAI) - optimum LAI in horticultural crops, canopy development; different stages of growth, growth curves, Crop development stages and dynamics (Case studies of annual/perennial horticultural crops), growth analysis in horticultural crops. Plant bio-regulators- auxin, gibberellin, cytokinin, ethylene inhibitors and retardants, basic functions, biosynthesis, role in crop growth and development, propagation, flowering, fruit setting, fruit thinning, fruit development, fruit drop, and fruit ripening. Tuvenitity, Flowering-factors affecting flowering, physiology of flowering, photoperiodism-long day, short day and day neutral plants, vernalisation and its application in horticulture, pruning and training physiological basis of training and pruning-source and sink relationship, translocation of assimilates. Physiology of seed development and maturation, seed dormancy and bud dormancy, causes and breaking methods in horticultural crops. Physiology of fruit growth and development, fruit setting, factors affecting fruit set and development, physiology of ripening of fruits-climacteric and non-climacteric fruits. Physiology of fruits under post-harvest storage**.**

Practical

Estimation of photosynthetic potential of horticultural crops, leaf area index, growth analysis parameters including harvest index, bioassay of plant hormones, identification of synthetic plant hormones and growth retardants, preparations of hormonal solution and induction of rooting in cuttings, ripening of fruits and control of flower and fruit drop. Important physiological disorders and their remedial measures in fruits and vegetables, seed dormancy, seed germination and breaking seed dormancy with chemicals and growth regulators.

Suggested Reading:

Salisbulry. 2007. *Plant Physiology.* CBS. New Delhi.

Taiz, L. 2010.Plant Physiology. SINAUR. USA.

Zeiger. 2003.Plant Physiology. PANIMA. New Delhi.

Edward E. Durna. 2014. Principles of Horticultural Physiology. CABI, UK.

Delvin, R.M . 1986. Plant Physiology. CBS. Delhi.

Richard, N. Arteca. 2004. Plant Growth Substances. CBS. New Delhi.

Jacobs, W. P. 1979. Plant Hormones And Plant Development. Cambridge Univ. London.

Basra, A. S. 2004. Plant Growth Regulators In Agriculture & Horticulture. HAWARTH press. New York.

Lincoln Taiz and Eduards Zeiger (5^{th} Edition). Plant physiology. Sinauer Associates, Inc.

Noggle G.R and Fritz T.G.1944. Introductory Plant Physiology.

Pandey and Sinha. Plant Physiology.

JKA Bleasdale, Plant Physiology in relation to Horticulture

Amarjit Basra, Plant Growth Regulators in Agriculture and Horticulture: Their role & Commercial Uses

C.Rajendran, K.Ramamoorthy and S. Juliet Hepziba, Nutritional and Physiological Disorders in Crop Plants

BAS-122 Information and Communication Technology 2(1+1)

Theroy

IT and its importance. IT tools, IT-enabled services and their impact on society; computer fundamentals; hardware and software; input and output devices; Features of machine language, assembly language, high-level language and their advantages and disadvantages; principles of programming- algorithms and flowcharts; Operating systems (OS) - definition, basic concepts, introduction to WINDOWS and LINUX Operating Systems; Local area network (LAN), Wide area network(WAN), Internet and World Wide Web, HTML and IP; Introduction to MS Office - Word, Excel, Power Point. Audio visual aids - definition, advantages, classification and choice of A.V aids; video conferencing. Communication process, Berlo' s model, feedback and barriers to communication.

Practical

Exercises on binary number system, algorithm and flow chart; MS Word; MS Excel; MS Power Point; Internet applications: Web Browsing, Creation and operation of Email account; Analysis of horticulture/agriculture data using MS Excel. Handling of audio visual equipments. Planning, preparation, presentation of posters, charts, overhead transparencies and slides. Organization of an audio visual programme.

Suggested Readings

Gurvinder Singh, Rachhpal Singh & Saluja KK. 2003. *Fundamentals of Computer Programming and Information Technology.* Kalyani Publishers.

Harshawardhan P. Bal. 2003. *Perl Programming for Bioinformatics*. Tata McGraw-Hill Education.

Kumar A 2015. *Computer Basics with Office Automation*. IK International Publishing House Pvt Ltd.

Rajaraman V & Adabala N. 2015. *Fundamentals of Computers*. PHI

BAS-123 Physical and Health Education (NC) 1(0+1)

Practical

Physical Education: Introduction to physical education. Posture, exercise for good posture, physical fitness exercises for agility, strength, coordination, endurance and speed. Rules are regulations of important games, skill development in any one of the games – football, hockey, cricket, volleyball, ball badminton, throw ball, tennikoit. Participation in one of the indoor games – shuttle badminton, chess and table tennis. Rules and regulations of athletic events, participation in any one of the athletic events – broad jump, high jump, triple jump, javelin throw, discuss throw, shot put, short and long distance running, Safety education, movement education, effective way of doing day-today activities. First-aid training, coaching for major games and indoor games. Asans and indigenous ways for physical fitness and curative exercises. Exercises and games for leisure time, use and experience. Importance of Asanas and Surya

namaskar. Free hand exercises and Yoga. Recreation: definition, agencies promoting recreation, camping and recreation. Note: Warming up and conditioning exercises are compulsory before the commencement of each class.

Suggested Reading:

O.P. Aneja. Encyclopaedia of Physical education, sports and exercise science (4 volumes).

Anil Sharma. Encyclopaedia of Health and Physical Education (7 Volumes).

N V Chaudhery, R Jain. Encyclopedia of Yoga Health and Physical Education (7 Volumes).

Pintu Modak, O P Sharma, Deepak Jain. Encyclopaedia of Sports and Games with latest rules and regulations (8 volumes).

Edwin F Bryant. Yoga sutrap of Patanjali.

BAS-124 Plant Biochemistry 2 (1+1)

Theory

Chemistry of carbohydrates – classification, mono, di and polysaccharides, Isomerism optical activitity, mutarotation, configuration of sugars and inversion.Chemistry of lipids – classification, simple lipids and phosphor lipids. Fatty acids and fat constants. Chemistry of amino acids and proteins, classification, levels of protein structure. Chemistry of nucleic acids – bases, sugars, Nucleosides and nucleotides. Structure and function of RNA and DNA. Enzymes : classification, mechanism of action, cofactors, enzyme kinetics, enzyme inhibition, allosteric enzymes, lysozymes, coenzymes. Metabolism of carbohydrates – glycolysis, TCA cycle electron transport chain. Lipids metabolism: beta oxidation and fatty acid biosynthesis. Photosynthesis – light reaction, dark reaction, Hill's reaction, photorespiration, C4 pathway, C3 and C4 plants, CO_2 fixation, regulation of photosynthesis. Plant hormones and their mode of action.

Practical

Qualitative tests for carbohydrates, Quantitative estimation of reducing sugars by DNS method, Quantitative test for total carbohydrates by Anthrone reagent, Qualitative tests for lipids, Determination of Saponification number of oils/fats, Determination of Iodine number of fatty acids, Qualitative tests for proteins/amino acids, Estimation of protein by Lowry's method, Estimation of DNA.

Suggested reading

Conn, E.E. and Stumpf, P.K. (1989). Outlines of Biochemistry, Wiley Eastern Ltd., New Delhi

Mazur, A and Harrows, B. (1971). Textbook of Biochemistry. W.B. Sanders Publications, New Delhi

Robert, C. B. (1983). Modern concepts in Biochemistry. Allyn and Bacon Inc. London

William, H.E. and Daphne, C.E.(2005). Biochemistry and Molecular Biology, Oxford University Press.

BAS-125 Statistical Methods & Experimental Designs 3 (2+1)

Theory

Basic concepts: Definition of Statistics, variables, types and sources of data, classification and tabulation of data. Construction of frequency distribution tables, graphic representation of data, simple, multiple component and percentage, bar diagram, pie diagram, histogram, frequency polygon and frequency curve average. Measures of location: mean, mode, median, geometric mean, harmonic mean, percentiles and quadrilles for raw and grouped data. Dispersion: Range, standard deviation, variance, coefficient of variation for raw and grouped data. Probability: Basic concept, additive and multiplicative laws. Theoretical distributions: binominal, poisson and normal distributions. Sampling: basic concepts, sampling vs.complete enumeration, parameter and statistic. sampling methods: basic concepts, simple random sampling and stratified random sampling. Tests of significance: Basic concepts, tests for equality mean, an independent and paired t-tests. Chi square tests for application of attributes and test for goodness to fit of mendalian ratios. Correlation: Scatter diagram, correlation co-efficient and its properties. Regression, fitting of simple linear regression, line of regression, tests of significance of correlation and regression co-efficient. Introduction to design of experiment: Basic principles of experimental design-replication, randomization and local control. Analysis of variance–assumptions and construction of ANOVA table, conclusions based on ANOVA. Comparisons based on means-critical difference, DMRT. Transformations of data - square root, logarithmic and angular transformations. Completely randomised design-Layout, analysis, advantages and limitations, Randomised block design - layout, analysis, choice of no. of blocks, advantages and limitations. Latin square designs - layout, analysis, applications, advantages and limitations.

Practical

Formation of frequency distribution, Diagrammatic and graphical representation. Calculation of different measures of central tendency.Computation of various measures of dispersion. Calculation of coefficient of variation Simple problems on probability, Selection of simple random sample and estimation of parameters. Large sample tests. Small sample tests, Problem based on t-tests and F-tests, Chi–square test, test of goodness of fit – test of independence of attributes in a contingency table. Analysis of variance - construction of ANOVA table of one-way classified data. Analysis of variance - construction of ANOVA table of two-way classified data. Layout and analysis of CRD, Layout and analysis of RBD. Analysis of data from 2^n factorial experiments in RBD. Formation of Yate's table: calculation of main effects and interaction effects. Layout and analysis of split-plot design.

Suggested reading

Anderson, R. L. and Bancroft, T. A. (1952). Statistical Theory in Research. Mc. Graw Hill Book Co., New York.

Cochran, W.G and Cox, G.M. (1958). Experimental designs. Wiley, New York

Das, M.N. and Giri, N.C. (1986). Design and Analysis of Experiments. Wiley Eastern Ltd., New Delhi. Federer, W.T. (1955), Experimental Design. Macmillan, New York.

Gomez, K. A. and Gomez, A. A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. New York. 680 p.

Kempthorne, O. (1952). The design and analysis of experiments. Wiley, New York.

Nigam A.K. and Gupta,V.K.(1979). Handbook on Analysis of Agricultural Experiments. IASRI Publication, New Delhi.

Panse, V. G. and P. V. Sukhatme. (1967). Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi, India.

Petersen Roger G. (1994) Agricultural Field Experiments: Design and Analysis. Marcel Dekker, New York.

BAS-126 Physical Education – II 1(0+1)

Practical

Concept of Health - Physical health, mental health, social health, spiritual health, spectrum of health. Fitness & wellness - Motor components. Regular exercises, Amount of training, Scientific way of training, Rest and relaxation, conditioning, Good posture, Heredity, Environment, Standard of living, Balance Diet, Stress & tension, Drugs, Intoxication. Means of Fitness Development - Aerobic activities, anaerobic activities, Sports & Games, Yoga, Recreational Activity. Safety Education – Swimming. Yoga - Meaning & importance of Yoga, Role of Yoga in life, Teaching of Yoga. Physical Fitness test - TPFP Fitness test: One mile run/ Beep test, Sit-Up 60sec, Sit and reach, Modified pull-ups. Major games - Rules and regulations of important game, Skill development in any one of the game - Hockey, Volleyball, Handball and Kho Kho. Indoor games - Participation in one of the indoor games – (Table Tennis & Badminton). Athletic events - Rules & regulations of athletic events participation in any one of the athletic events- Triple jump, Discus throw and Javelin throw. NOTE: (one to be selected, major games, indoor games and Athletic events)

BAS-211 Fundamentals of Extension Education 2 (1+1)

Theroy

Extension education: meaning, definition, nature, scope, objectives, principles, approaches and history. Horticulture extension: process, principles and selected programmes of leading national and international forest institutes. People's participation in Horticulture programmes. Motivation of Farmers, rural youth and voluntary organizations for Horticulture extension work Rural Development: meaning, definition, objectives and genesis. Transfer of technology programmes like lab to land programme (LLP) national demonstration (ND), front line demonstration (FLD) Krishi Vigyan Kendras (KVK), Technology Assessment and Refinement Programme (TARP) etc. of ICAR, ATMA, RKVY. Communication: meaning, definition, elements and selected models. Audio – visual aids: importance, classification and selection. Adoption and diffusion process, Teaching and learning-concepts and principles, Teaching steps, Programming planning process – meaning, scope, principles and steps. Evaluation: meaning, importance and methods.

Scope and importance of Participatory Rural Appraisal (PRA) & Rapid Rural Appraisal (RRA). Management and administration: meaning, definition, principles and functions. Concepts of human resource development (HRD), rural leadership. ICT in Extension education, ICT use in rural India

Practical

Visits to study structure, functions, linkages and extension programmes of ICFRE institutes/voluntary organizations/Mahila Mandal, Village Panchayat, State Dept. of Horticulture /All India Radio (AIR). Exercises on distortion of message, script writing for farm broadcasts and telecasts, planning, preparation & use of NPVA like poster, chart, flash cards, folders etc. and AVA like OHP. Identification of local leaders to study their role in extension work. Evaluation of some selected case studies of forestry extension programmes. Preparation of Village Agricultural productions plan.

Suggested Reading:

Adivi Reddy, A., 2001, *Extension Education*, Sree Lakshmi press, Bapatla.

Dahama, O. P. and Bhatnagar, O.P., 1998, *Education and Communication for Development*, Oxford and IBH publishing Co. Pvt. Ltd., New Delhi.

Jalihal, K. A. and Veerabhadraiah, V., 2007, *Fundamentals of Extension Education and Management in Extension*, Concept publishing company, New Delhi.

Muthaiah Manoraharan, P. and Arunachalam, R., *Agricultural Extension*, Himalaya Publishing House (Mumbai).

Sagar Mondal and Ray, G. L., *Text Book On Rural Development, Entrepreneurship And Communication Skills*, Kalyani Publications.

Rathore, O. S. *et al.*, 2012, *Handbook of Extension Education*, Agrotech Publishing Academy, Udaipur.

Ray, G. L., 1991 (1st Edition), *Extension Communication and Management*, Kalyani Publishers, Ludhiana {7th revised edition - 2010}.

Supe, S. V., 2013 (2nd Edition), *A Text Book of Extension Education*, Agrotech Publishing Academy, Udaipur.

Van Den Ban, A. W. and Hawkins, H. S., *Agricultural Extension*, S. K .Jain for CBS Publishers & Distributors, New Delhi.

M Hilaris Indian agriculture and information: Soundari, New century ublications, 2011and communication technology (ICT)

BAS-212 Elementary Plant Biotechnology 2(1+1)

Theroy

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;

Somatic embryogenesis and synthetic seed production technology. Protoplast isolation, Culture, and Fusion; Products of somatic hybrids and cybrids, Applications in crop improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer, Gene cloning, Direct and indirect method of gene transfer. Transgenic plants and their applications. Blotting techniques, DNA finger printing, DNA based markers: RFLP, AFLP, RAPD, SSR and DNA Probes, Mapping QTL: Future prospects. MAS, and its application in crop improvement. Nanotechnology: Definition and scope, types of nano material and their synthesis, Tools and techniques to characterize the nano particles. Nano-biotechnological applications with examples.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants; Aseptic manipulation of various explants; Callus induction and Plant Regeneration; Micro propagation of important crops; Anther, Embryo and Endosperm culture; Hardening / Acclimatization of regenerated plants; Somatic embryogenesis and synthetic seed production; Isolation of protoplast; Demonstration of Culturing of protoplast; Demonstration of Isolation of DNA; Demonstration of Gene transfer techniques, direct methods; Demonstration of Gene transfer techniques, indirect methods; Demonstration of Confirmation of Genetic transformation; Demonstration of gel-electrophoricsis techniques. Green synthesis of nano particles and their size characterization.

Suggested Reading:

Singh, B D, 2004. *Biotechnology Expanding Horizons* 2nd Edn. Kalyani Publishers, New Delhi.

Gupta, P.K., 2015. *Elements of Biotechnology* 2nd Edn. Rastogi and Co., Meerut.

Razdan M K, 2014. *Introduction to plant Tissue Culture* 2nd Edn. Science Publishers, inc. USA.

Gautam V K, 2005. *Agricultural Biotechnology*. Sublime Publications

Thomar, R.S., Parakhia, M.V., Patel, S.V. and Golakia, B.A., 2010. *Molecular markers and Plant biotechnology*, New Publishers, New Delhi.

Purohit, S.S., 2004. *A Laboratory Manual of Plant Biotechnology* 2nd Edn. Agribios, India.

Singh, B.D. 2012. *Plant biotechnology*. Kalyani publishers, Ludhiana

Bilgrami, K.S. and Pandey, A.K.1992. *Introduction to biotechnology*. CBS Pub. New Delhi

Gupta, P.K. 1994. *Elements of biotechnology*. Rastogi Pub. Meerut.

Chahal, G.S. and Gosal, S.S.2003. *Principles and procedures of plant approaches breeding Biotechnological and conventional*. Narosa Publishing House, New Delhi

BAS-213 Physical Education-III 1 (0+1)

Practical

Lifestyle diseases & dietary and lifestyle changes that reduce the incidence of chronic diseases. Obesity, Coronary heart diseases (CAD), ischemic stroke Diabetes Mellitus, Blood pressure, Osteoporosis. Injuries - Injuries in sports, Prevention of sports injuries. First aid training in sports - Sprain, Fractures, Burns, Snake bite, Drowning, Unconscious victim, First

aid ABC, First aid CPR, Sling and Splint and carrying techniques. Yoga continuation. Major games, Rules & regulation of important games, Skill development in any one of the game- Cricket, Football, Basketball, Volley Ball and Netball. Athletic events - Rules & regulations of athletic events – participation in any one of the athletic events- short & long distance running. Anyone to be selected major games and Athletics events. Adventure training - On Land – Trekking, High Altitude Trekking, Rock Climbing, Mountaineering. In water - River Crossing.

BAS-221 Study Tour 1 (0+1*)

Practical

Study tour of one week duration in the respective States/part of India. To familiarize the students with the fauna, flora and other research activities of SAUs, Research institute, forest industries, Govt. and private organizations of different parts of respective states/ part of India. To expose the students to various national / heritage monuments as part of national integration activity.

BAS-311 Forest Economics and Marketing 3(2+1)

Theory

Economics- Meaning, definition, subject matter- Divisions of economics - Importance of economics- Forest Economics- Meaning, definition- Basic concepts - Goods, services, utility, value, price, wealth, welfare, Wants- Meaning, characteristics, classifications of wants, importance. Theory of consumption- Law of diminishing marginal utility, meaning, definition, assumption, illustration, limitations, law of equi-marginal utility-Importance. Consumer 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 demand, elasticity of demand, importance of elasticity of demand –supply- meaning, supply function-Law of supply-factors influencing supply –Pricing of timber and non-timber products-Economics of timber and non-timber forest products. Forest planning–forest policy and development. Production-Meaning, factors of production -land, labour, capital, organization, entrepreneurship - Distribution-rent, wages, interest, profit- National Income-definition and concepts-.Public finance- meaning- Public resource- Meaning- sources-Taxation-types-Public expenditure - meaning, Principles- Money –meaning –evolution, Inflation: definition, types of inflation-Welfare economics-Meaning and basic concepts.

Marketing- definition – Marketing Process – Need for marketing – Role of marketing — Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agricultural produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Techno-economic parameters for preparation of projects. Preparation of Bankable projects for various agricultural products and its value added products. Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

BAS-321 Horti-Business Management 2 (2+0)

Theroy

Farm management - definition, nature, characteristics, scope, principles and decision making, production function, technical relationships, cost concepts, curves and functions – factors, product, relationship – factors relationship, product relationship, optimum conditions, principles of opportunity cost of equimarginal returns and comparative advantages, time value of money, economic of scale, returns to scale, cost of cultivation and production, break even analysis, decision making under risk and uncertainty. Farming systems and types. Planning – meaning, steps and methods of planning, types of plan, characteristics of effective plans. Organizations – forms of business organizations, organizational principles, division of labour. Unity of command, scalar pattern, job design, span of control responsibility, power authority and accountability. Direction – guiding, leading, motivating, supervising, coordination – meaning, types and methods of controlling – evaluation, control systems and devices. Budgeting as a tool for planning and control. Record keeping as a tool of control. Functional areas of management – operations management – physical facilities, implementing the plan, scheduling the work, controlling production in terms of quantity and quality. Materials management – types of inventories, inventory costs, managing the inventories, economic order quantity (EOQ). Personnel management – recruitment, selection and training, job specialization. Marketing management – definitions, planning the marketing programmes, marketing mix and four P's. Financial management – financial statements and ratios, capital budgeting. Project management – project preparation and evaluation measures.

Suggested Reading

Heady Earl O and Herald R. Jenson,1954, *Farm Management Economics*. Prentice Hall, New Delhi

S.S. Johl, J.R. Kapur ,2006, *Fundamentals of Farm Business Management*.

Kalyani Publishers, New Delhi

Karan Singh and Kahlon A S. *Economics of Farm Management in India*. Theory and Practice. New Delhi. Allied

L.M. Prasad. 2001. *Principles and Practices of Management*, 9th Ed. S. Chand & Sons, New Delhi.

Koontz Harold. *Principles of Managemen*t. Tata McGraw-Hill Education Private Limited, New Delhi.

P.C. *Thomas. Managerial Economics*, 9th Ed. Kalyani Publishers.

K.K. Dewett and M.H. Navalur. *Modern Economic Theory*. S. Chand & Sons, New Delhi.

P. Subba Rao. *Human Resource Management*. Himalaya Publications.

S.P. Jain. *Financial Accounting*. Kalyani Publications, Ludhiana.

Shapiro E. *Macroeconomic analysis*. Galgotia Publications Delhi
Barry P J, Hopkins J A and Baker C B. *Financial Management in Agriculture*, 6th ed. Danville, IL Interstate Publishers.
Gittiner, J P., *Economic analysis of agricultural projects*. The John Hopkins University Press Baltimore, USA, 1982
Benjamin Mc Donald P 1985. *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK
Pandey U K 1990. *An Introduction to Agricultural Finance* .Kalyani Publishers New Delhi.

BAS-322 Entrepreneurship Development and Business Management 2(1+1)

Theroy

Entrepreneurship Development: Assessing overall business environment in the Indian economy. Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship; entrepreneurial and managerial characteristics; managing an enterprise; motivation and entrepreneurship development; importance of planning, monitoring, evaluation and follow up; managing competition; entrepreneurship development programs; 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 relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Supply chain management and total quality management. Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business. Communication Skills: meaning and process of communication, verbal and non-verbal communication; listening and note taking, writing skills, oral presentation skills developing organizational and managerial skills, problem solving skills. field diary and lab record; indexing, footnote and bibliographic procedures.

Practical

Listening and note taking, writing skills, oral presentation skills; field diary and lab record; indexing, footnote and bibliographic procedures. Reading and comprehension of general and technical articles, précis writing, summarizing, abstracting; Conducting market survey to the demand for product, preparing advertisements for popularization of product, news writing, preparing project proposals, individual, group presentation, features of oral presentation, presentation, evaluation of presentation and evaluation of sheet, dyanamic communication-face to face conversation, telephone conversation, rate of speech and clarity of voice, speaking and listening politeness, telephone etiquettes, organising general and group meeting, salient features of participation in seminars and conferences, conducting and participating in mock interviews.

Suggested Reading:

Benjamin MC Donald P. 1985, *Investment Projects in Agriculture- Principles and Case studies*. Longman Group Limited. Essex. UK.

Chole, R. R. *et al.*, 2012, *Entrepreneurship Development and Communication skills*, Scientific publishers, Jodhpur.

Gittiner, J P., 1982, *Economic Analysis of Agricultural Projects*, The John Hopkins University Press Baltimore, USA.

Hopkins J A and Baker C B Danville, *Financial Management in Agriculture*, 6th ed Barry P J, IL Interstate Publishers.

Kotler Philip and Armstrong, *Principles of Marketing*. Prentice-Hall.

Pandey U. K., *An Introduction to Agricultural Finance.*

Sagar Mondal and G. L. Ray, *Text Book on Rural Development, Entrepreneurship and Communication Skills,* Kalyani Publications.

Somani, L. L., *Extension Education and Communication*, Agrotech, Publishing Academy, Udaipur.

Dr. A.K. Singh, 2009.Entrepreneurship Development and Management. Lakshmi Publications Ltd.,

S. Anil Kumar, S.C Poornima, M.K. Abhraham and K. Jayashree, 2008; Entrepreneurship Development. New Age International Publishers

BAS-411 Forest Biotechnology 3(2+1)

Theory

Concepts and history of Plant Biotechnology: Scope and importance in tree 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 in tree improvement. Genetic engineering; Restriction enzymes; Vectors for gene transfer – Gene cloning – Direct and indirect method of gene transfer – Transgenic plants. their applications , achievements and biosafety regulations. Brief introduction to blotting techniques – DNA finger printing and bar coding – DNA based markers – RFLP, AFLP, RAPD, SSR, VNTRS,CAPS, SNPs, ESTs and DNA Probes – Mapping QTL – Future prospects. MAS, and its application in tree improvement.

Practical

Requirements for Plant Tissue Culture Laboratory; Techniques in Plant Tissue Culture; Media components and preparations; Sterilization techniques and Inoculation of various explants.

Suggested reading

Bajaj, Y.P.S. (Ed) (1988). Biotechnology in Agriculture and Forestry 2. Crops 1. Springer-Verlag, Berlin.

Dhawan, V (2012) Applications of Biotechnology in Forestry and Horticulture. Springer US

Guptha, P.K. (2000). Elements of Biotechnology. Rastogi publications, Meerut.

Neumann, K.H., Kumar, A., and Sopory, S.K. (2008) Recent Advances in Plant Biotechnology and Its Applications. I. K. International Pvt Ltd

Punia, M.S. (1998). Plant Biotechnology and Molecular Biology. A laboratory manual. Scientific Publishers, Jodhpur

Thieman, W.J. and Palladino, M.A. (2009). Introduction to Biotechnology, Second Edition. Pearson Benjamin Cummings, San Fransis

BAS-412 Agricultural Informatics 3 (2+1)

Theory

Computer Programming, General Concepts, Documentation and Program Maintenance, Debugging programs, Errors. Introduction to Visual Basic, Java, Fortran, C/ C++, etc, concepts and standard input/output operations, Variables and Constants, Operators and Expressions, Flow of control, Inbuilt and User defined functions, programming techniques for agriculture/forestry.

e-Agriculture, concepts, design and development. Application of innovative ways to use information and communication technologies (IT) in agriculture/forestry. ICT for Data Collection, formation of development prorammes, monitoring and evaluation of Programmes. Computer Models in agriculture/forestry: statistical, weather analysis and crop simulation models, concepts, structure, inputs-outputs files, limitation, advantages and application of models for understanding plant processes, sensitivity, verification, calibration and validation. IT application for computation of water and nutrient requirement of crops, Computer-controlled devices (automated systems) for Agri-input management, Smartphone mobile apps in Agriculture for farm advises, market price, postharvest management etc; Geospatial technology, concepts, techniques, components and uses for generating valuable agri-information. Decision support systems, taxonomy, components, framework, classification and applications in agriculture/forestry, DSS, Agriculture Information/Expert System, Soil Information Systems etc for supporting Farm decisions. Preparation of contingent crop-planning and crop calendars using IT tools.

Practical

Study of Computer Components, accessories, practice of important DOS Commands. Introduction of different operating systems such as windows, Unix, Linux, Creating, Files & Folders, File Management. Use of MS-WORD and MS Power point for creating, editing and presenting a scientific Document, Handling of Tabular data, animation, video tools, art tool, graphics, template & designs. MS-EXCEL - Creating a spreadsheet, use of statistical tools, writing expressions, creating graphs, analysis of scientific data, handling macros. MS-ACCESS: Creating Database, preparing queries and reports, demonstration of Agri-information system.

Introduction to World Wide Web (WWW) and its components, creation of scientific website, presentation and management agricultural information through web. Introduction of various programming languages such as Visual Basic, Java, Fortran, C, C++, and their components Hands on practice on writing small programmes. Hands on practice on Crop Simulation Models (CSM), DSSAT/Crop-Info/CropSyst/ Wofost. Preparation of Inputs file for CSM and study of model outputs, computation of water and nutrient requirements of crop using CSM and IT tools. Use of smart phones and other devices in agro-advisory and dissemination of market information. Introduction of Geospatial Technology, demonstration of generating information important for Agriculture. Hands on practice on preparation of Decision Support System.

BAS-421 All India Study Tour 3 (0+3*)

Three weeks' duration

To familiarize the students with the flora , fauna and other research activities of SAUs, research institutes, forest industries, govt. and private organization of different parts of India. To expose the students to various national / heritage monuments as part of national integration activity.

NCC/NSS-I 1(0+1)

NCC

Introduction to NCC, defense services, system of NCC training, foot drill, sizing, forming up in three ranks, open and close order march, dressing, getting on parade, dismissing and falling out, saluting, marching, arms drill, shoulder arm, order arm, present arm, guard of honour, ceremonial drill.

NSS

Aims and objectives of NSS. NSS logo, motto etc. Orientation of students in national problems, study of philosophy of NSS, fundamentals rights, directive principles of state policy, Village adoption.

SYLLABUS

For

B.Sc. (Hons.) Horticulture

2018-19

FACULTY OF HORTICULTURE
AGRICULTURE UNIVERSITY, KOTA

Syllabus of B.Sc. (Hons.) Horticulture

FRS-111 Fundamentals of Horticulture 3 (2+1)

Theory

Scope and importance, classification of horticultural crops and nutritive value, area and production, exports and imports, fruit and vegetable zones of India and of different states, nursery techniques and their management, soil and climate, vegetable gardens, nutrition and kitchen garden and other types of gardens – principles, planning and layout, management of orchards, planting systems and planting densities. Production and practices for fruit, vegetable and floriculture crops. Principles objectives, types and methods of pruning and training of fruit crops, types and use of growth regulators in horticulture, water management– irrigation methods, merits and demerits, weed management, fertility management in horticultural crops-manures and fertilizers, different methods of application, cropping systems, intercropping, multi-tier cropping, mulching– objectives, types merits and demerits, Classification of bearing habits of fruit trees, factors influencing the fruitfulness and unfruitfulness. Rejuvenation of old orchards, top working, frame working, principles of organic farming, market chain management.

Practical

Identification of various horticultural crops, tools and implements, Features of orchard, planning and layout of orchard, layout of nutrition garden, preparation of nursery beds for sowing of vegetable seeds, digging of pits for fruit plants, planting systems, training and pruning of orchard trees, preparation of fertilizer mixtures and field application, preparation and application of growth regulators, layout of different irrigation systems, identification and management of nutritional disorder in fruits, assessment of bearing habits, maturity standards and harvesting.

Suggested Reading:

Prasad and Kumar, 2014. *Principles of Horticulture* 2nd Edn. Agrobios (India).

Neeraj Pratap Singh, 2005. *Basic concepts of Fruit Science* 1st Edn. IBDC Publishers.

Gardner/Bardford/Hooker. J.R., 1957. *Fundamentals of Fruit Production*. Mac Graw Hill Book Co., New York.

Edmond,J.B, Sen,T.L, Andrews,F.S and Halfacre R.G., 1963. *Fundamentals of Horticulture*. Tata Mc Graw Hill Publishing Co., New Delhi.

Kumar, N., 1990. *Introduction to Horticulture*. Rajyalakshmi publications, Nagarcoil, Tamilnadu

Jitendra Singh, 2014. *Basic Horticulture*. Kalyani Publishers, Ludhiana.

Denisen E.L.,1957. *Principles of Horticulture*. Macmillan Publishing Co., New York.

Chadha, K.L. (ICAR), 2002, 2001. *Hand book of Horticulture* . ICAR, New Delhi

K.V.Peter, 2009. *Basics Horticulture.* New India Publishing Agency

Kausal Kumar Misra and Rajesh Kumar, 2014. *Fundamentals of Horticulture* .Biotech Books.

D.K. Salunkhe and S.S. Kadam, 2013. *A handbook of Fruit Science and Technology*. CRC Press.

S. Prasad and U. Kumar, 2010. *A handbook of Fruit Production*. Agrobios (India).

Amar Singh (2009) Fruit Physiology, Kalyani Publishers, Ludhiana

FRS-112 Principles of Genetics and Cytogenetics 3 (2+1)

Theory

Historical background of genetics, theories and hypothesis. Physical basis of heredity, cell reproduction, mitosis, meiosis and its significance. Gametogenesis and syngamy in plants. Mendelian genetics–Mendel's principles of heredity, deviation from Mendelian inheritance, pleiotropy, threshold characters, co-dominance, penetrance and expressivity. Chromosome theory of inheritance, gene interaction. Modification of monohybrid and dihybrid rations. Multiple alleles, quantitative inheritance linkage and crossing over, sex linked inheritance and characters. Cytoplasmic inheritance and maternal effects. Chemical basis of heredity, structure of DNA and its replication. Evidence to prove DNA and RNA – as genetic material. Mutations and their classification. Chromosomal aberrations, changes in chromosome structure and number.

Practical

Study of fixatives and stains. Squash and smear techniques. Demonstrations of permanent slides and cell division, illustration in plant cells, pollen fertility and viability, determination of gametes, Solving problems of monohybrid, dihybrid, and test cross ratios using chi-square test, gene interactions, estimation of linkages using three point test cross from F_2 data and construction of linkage maps. Genetics variation in pea.

Suggested Reading:

Gardner E J, Simmons M J &Snustard D P. *Principles of Genetics (VIII Edn)*. John Wiley & Sons, New York.

Strickberger. *Genetics*. Macmillan Publishing Company, New York.

William D. Stansfield. *Theory and Problems of Genetics (3rd Ed).* Schaum's Outline series - McGraw-Hill Inc.

Benjamin Lewin. *Genes (II edn).* John Wiley & Sons, New York.

Phundan Singh. *Elements of Genetics*. Kalyani publishers, New Delhi.

Swanson & Webster. *The Cell* (V edn). Prentice Hall of India Pvt. Ltd, New Delhi

Norman,V. Rothwell. *Understanding Genetics* (IV Ed.). Oxford University Press, Oxford.

Sinnut, Dunn & Dobzhansky. *Principles of Genetics* XIX reprint. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Griffiths, Miller, Suzuki Lewontin & Gelbart. *An introduction to Genetic Analysis* (V *Ed.).* W.H.Freeman & Company, Newyork

Robert Schieif. *Genetics & Molecular Biology* (1986). The Benjamin/cummings publishing Co, Inc, California.

Swanson, Merz & Young. *Cytogenetics* (II ed.). Prentice Hall of India Pvt. Ltd. New Delhi.

Joseph Jahier& INRA working group. *Techniques of Plant Cytogenetics* (1986). Oxford & IBH Publishing Co Pvt.Ltd., New Delhi

Loewy & Siekevitz. *Cell Structure & Function* (II Ed.). Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi.

Stent & Calendar. *Molecular Genetics* (II Ed.). CBS Publishers, New Delhi

Singh B D. *Fundamentals of Genetics*. Kalyani Publishers, New Delhi

Srivastava&Tyagi. *Selected Problems in Genetics* (Vol.1-3). Anmol Publications Pvt. Ltd., New Delhi
Khanna VK. Genetics–*Numerical Problems*. Kalyani Publishers, New Delhi.
Farook& Khan. *Genetics & Cytogenetics* (I Ed.). Premier Publishing House, Hyderabad.
Shukla. *Cell Biology* (2001). Dominant publishers, New Delhi
George Acquaah. *Principles of Plant Genetics and Breeding*. Blackwell
B.D. Singh. *Fundamental of Genetics*. Kalyani. India
Gupta, P.K. 1985.*Cytology, genetics and cytogenetics*. Rastogi Publication, India.

FRS-121 Tropical and Sub-Tropical Fruits 3 (2+1)

Theory

Horticultural classification of fruits including genomic classification. Horticultural zones of India, detailed study of area, production and export potential, varieties, climate and soil requirements, propagation techniques, planting density and systems, after care, training and pruning. Management of water, nutrient and weeds. Special horticultural techniques including plant growth regulators, their solution preparation and use in commercial orchards. Physiological disorders. Post-harvest technology, harvest indices, harvesting methods, grading, packaging and storage of the following crops:

Mango, banana, grapes, citrus, papaya, sapota, guava, pomegranate, bael, ber, amla, anona, fig, pineapple, jackfruit, avocado, mangosteen, litchi, carambola**, karonda, tamarind, phalsa**, loquat, **jamun, lasoda** and passion fruit. Bearing in mango and citrus, causes and control measures of special production problems, alternate and irregular bearing overcome/control measures. Seediness and kokkan disease in banana, citrus decline and casual factors and their management. Bud forecasting in grapes. Sex expression and seed production in papaya, latex extraction and crude papain production, economics of production.

Practical

Description and identification of varieties based on flower and fruit morphology in above crops. Training and pruning of **ber, phalsa**, grapes, mango, guava and citrus. Selection of site and planting system, pre-treatment of banana suckers, desuckering in banana, sex forms in papaya. Use of plastics in fruit production. Visit to commercial orchards and diagnosis of maladies. Manure and fertilizer application including bio-fertilizer in fruit crops, preparation and application of growth regulators in **citrus, guava** and mango. Seed production in papaya, latex extraction and preparation of crude papain. Ripening of fruits, grading and packaging, production economics for tropical and sub-tropical fruits. Mapping of arid and semi-arid zones of India. Botanical description and identification of ber, fig, jamun, pomegranate, carissa, phalsa, wood apple, **citrus**, tamarind, aonla, bael and annona.

Suggested Reading:

H.P.Singh and M.M.Mustafa, 2009. *Banana*-new innovations. Westville Publishing House, New Delhi.
M.S.Ladaniya, 2013. *Citrus Fruits*. Elsevier, India post ltd.

Bose, T.K., Mitra, S.K. and Sanyal, D., 2002. *Tropical and Sub-Tropical*-Vol-I. Naya udyog-Kolkata
Rajput, CBS and Srihari babu, R., 1985. *Citriculture*. Kalyani Publishers, New Delhi.
Chundawat, B.S., 1990. *Arid fruit culture*. Oxford and IBH, New Delhi.
Chadha,K.L. (ICAR) 2002, 2001. *Hand book of Horticulture*. ICAR, New Delhi.
Symmonds, 1996. *Banana*. II Edn. Longman, London.
Radha T and Mathew L., 2007. *Fruit crops*. New India Publishing Agency.
W S Dhillon, 2013. *Fruit Production in India.* Narendra Publishing House, New Delhi
T.K.Chattopadhyay, 1997. *Text book on pomology*. Kalyani Publishers, New Delhi.
R.E.Litz, 2009. *The Mango* 2nd Edn. Cabi Publishing, Willingford, U.K.
K.L.Chadda, 2009. *Advanced in Horticulture*. Malhotra Publishing House, New Delhi.
S.P. Singh, 2004. *Commercial fruits.* Kalyani Publishers, New Delhi.
F.S. Davies and L.G.Albrigo, 2001. *Citrus*, Cab International.

FRS-122 Principles of Plant Breeding 3 (2+1)

Theory

Plant breeding as a dynamic science, genetic basis of Plant Breeding – classical, quantitative and molecular, Plant Breeding in India – limitations, major achievements, goal setting for future. Sexual reproduction (cross and self-pollination), asexual reproduction, pollination control mechanism (incompatibility and sterility and implications of reproductive systems on population structure). Genetic components of polygenic variation and breeding strategies, selection as a basis of crop breeding and marker assisted selection Hybridization and selection – goals of hybridization, selection of plants; population developed by hybridization – simple crosses, bulk crosses and complex crosses. General and special breeding techniques. Heterosis – concepts, estimation and its genetic basis. Calculation of heterosis, heterobeltosis, GCA, SCA, inbreeding depression, heritability and genetic advance. Emasculation, pollination techniques in important horticultural crops. Breeding for resistance of biotic and abiotic stresses. Polyploidy breeding. Mutation breeding.

Practical

Breeding objectives and techniques in important horticultural crops. Floral biology – its measurement, emasculation, crossing and selfing techniques in major crops. Determination of mode of reproduction in crop plants, handling of breeding material, segregating generations (pedigree, bulk and back cross methods), Field layout, and maintenance of experimental records in self and cross pollinated crops. Demonstration of hybrid variation and production techniques. Hardy Weinberg Law and calculation, male sterility and incompatibility studies in horticultural crops calculation of inbreeding depression, heterosis, heterobeltioses, GCA, SCA, GA, heritability.

Suggested Reading:

R.W. Allard. *Principles of plant breeding*. John Wiley & Sons, New York**.**
V.L. Chopra. *Plant breeding: Theory and Practice.* Oxford & IBH Publ. Co., New Delhi.
Phundan Singh. *Essentials of plant breeding*. Kalyani Publishers
J.R. Sharma. *Principles and practices of plant breeding*. Tata McGraw Publ., New Delhi
B.D. Singh. *Plant breeding : principles and methods*. Kalyani Publishers, Ludhiana.
R.C. Chaudhary. *Plant Breeding*
Hays and Garber. *Breeding crop plants*. Mc Graw Hill Publications, New York

G K Kallo. *Breeding of vegetables*. Panima publishers, New Delhi

W.R. Fehr. *Principles of cultivar development: theory and technique (Vol. 1).* Macmillan Publishing Company, New York.

D.S. Falconer. *Introduction to quantitative genetics*. Longman Scientific & Technical, Longman Group, UK, Ltd., England.

R.K. Singh and B.D. Chaudhary. *Biometrical methods in quantitative genetic analysis.* Kalyani Publishers, Ludhiana.

K. Mather and J.L Jinks. *Introduction to Biometrical genetics*. Chapman and Hall, London

B D Singh. *Fundamental of Plant breeding*. Kalyani. India.

Pundan Singh. *Essentials of plant breeding*. Kalyani. India

G. S. Chahal and S.S. Gosal. 2002. *Principles and Procedures of Plant Breeding*. Narosa Publishing House, New Delhi.

Poehlman, J.M. and Borthakar, D. 1995. *Breeding Asian Field Crops*. Oxford& IBH Publishing Co., New Delhi

FRS-123 Plant Propagation and Nursery Management 2 (1+1)

Theory

Propagation: Need and potentialities for plant multiplication, sexual and asexual methods of propagation, advantages and disadvantages. Seed dormancy types of dormancy (**method to overcome dormancy**- scarification and stratification), internal and external factors, phytotrons **nursery, nursery techniques**, nursery management, apomixes, monoembryony, polyembrony, chimera and bud sport. Propagation Structures: Mist chamber, humidifiers, greenhouses, glasshouses, cold frames, hot beds, poly-houses, use of growth regulators in seed **(**types and stages of seed germination with examples) and vegetative propagation, **methods and techniques of propagation through specialized organs (corm, runners, suckers)**, division-stolons, pseudobulbs, offsets, cutting, layering, grafting, formation of graft union, factor affecting, healing of graftage and budding, physiological and bio chemical basis of rooting, factors influencing rooting of cuttings and layering, graft incompatibility. Anatomical studies of bud union, selection and maintenance of mother trees, collection of scion stick, scion-stock relationship, and their influences, bud wood certification. Micrografting, meristem culture, callus culture, anther culture, organogenesis, somaclonal variation, hardening of plants in nurseries. Nursery registration act. Insect/pest/disease control in nursery.

Practical

Identification of nursery tools use of media for propagation of plants in nursery beds. Preparation of nursery beds and sowing of seeds. Raising of rootstock and **use of virus testing plant material**. Seed treatments for breaking dormancy and inducing vigorous seedling growth. Preparation of plant material for potting and **repotting**. Hardening plants in the nursery. Practicing different types of cuttings, layering, graftings and buddings including opacity and grafting, top grafting and bridge grafting etc. Use of mist chamber in propagation and hardening of plants. Preparation of plant growth regulators for seed germination and vegetative propagation. Visit to a tissue culture laboratory. **Lifting**, labelling and packing of nursery fruit plants. Maintenance of nursery records. Cost of establishment of a mist chamber, greenhouse, glasshouse, polyhouse and their maintenance. Nutrient and plant protection applications during nursery.

Suggested Reading:

Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Jr. and Robert L. Geneve. *Plant Propagation- Principles and Practices(7th Edition)*. PHI Learning Private Limited, New Delhi-110001

T.K.Bose, S.K.Mitra, M.K.Sadhu, P. Das and D.Sanyal. *Propagation of Tropical & Subtropical Horticultural Crops, Volume 1(3rd Revised edition).* Naya Udyog, 206, Bidhan Sarani, Kolkata 700006.

Guy W. Adriance and Feed R. Brison. *Propagation of Horticultural Plants*. Axis Books (India).

S. Rajan and B. L. Markose (series editor Prof. K.V.Peter). *Propagation of Horticultural Crops- Horticulture Science Series vol.6.* New India Publishing Agency, Pitam Pura, New Delhi-110088.

Hartman,H.T and Kester,D.E.1976.*Plant Propagation Principles and practices*. Prentice hall of India Pvt.Ltd., Bombay.

Sadhu,M.K.1996. *Plant Propagation*. New age International Publishers, New Delhi.

Mukhergee,S.K. and Majumdar,P.K.1973.Propagation of fruit crops. ICAR, New Delhi.

Ganner,R.J. and Choudhri,S.A.1972.*Propagation of Tropical fruit trees*. Oxford and IBN publishing Co., New Delhi.

Sarma,R.R.2002. *Propagation of Horticultural Crops*.Kalyani Publishers,(Principles and practices) New Delhi.

Symmonds,1996. *Banana.II* edition Longman, London.

Chundawat,B.S. 1990.*Arid fruit culture*. Oxford and IBH, New Delhi.

Chadha,K.L. (ICAR)2002,2001.*Hand book of Horticulture*. ICAR, New Delhi.

Bose ,T.K.Sanyal, D and Sandhu, M.L.(1998) Propagation of Horticultural crops. Naya Prakash Publishers , Kolkatta .

FRS-211 Temperate Fruit Crops 2 (1+1)

Theory

Classification of temperate fruits, detailed study of areas, production, varieties, climate and soil requirements, propagation, planting density, cropping systems, after care training and pruning, self-incompatibility and pollinisers, use of growth regulators, nutrient and weed management, harvesting, post-harvest handling and storage of apple, pear, peach and **nectarine**, apricot, plum, cherry, persimmon, strawberry, kiwi, queens land nut (macademia nut), almond, walnut, pecan nut, hazel nut and chest nut. Re-plant problem, rejuvenation and special production problems like pre-mature leaf fall, physiological disorders, important insect – pests and diseases and their control measures. Special production problems like alternate bearing problem and their remedies.

Practical

Nursery management practices, description and identification of varieties of above crops, manuring and fertilization, planting systems, preparation and use of growth regulators, training and pruning in apple, pear, plum, peach and nut crops. Visit to private orchards to diagnose maladies. Working out economics for apple, pear, plum and peach.

Suggested Reading:

Chattopadhyay T.K.2009.*A text book on Pomology-IV Devoted to Temperate fruits*. Kalyani Publishers.B-1/292,Rajinder Nagar,Ludhiana-141008

Banday F.A. and Sharma M.K.2010.*Advances in Temperate Fruit Production*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.

Kaushal Kumar Misra.2014.*Text book of Advanced Pomology. Biotech Books.*4762-63, Ansari Road, Darya Ganj, New delhi-11002.

Das B.C and Das S.N .*Cultivation of Minor Fruits*. Kalyani Publishers.B-1/292, Rajinder Nagar, Ludhiana-141008.

Pal J.S.2010. *Fruit Growing* .2010. Kalyani Publishers.B-1/292,Rajinder Nagar, Ludhiana-141008.

Mitra S.K, Rathore D.S and Bose T .K. 1992. *Temperate Fruit Crops. Horticulture and Allied* Publishers, Calcutta.

Chattopadhya, T.K. 2000. *A Text Book on Pomology (Temperate Fruits)* Vol. IV Kalyani Publishers, Hyderabad

Chadha, T.R, 2001. *Text Book of Temperate Fruits*. Indian Council of Agricultural Research, New Delhi.

David Jackson & N E Laone, 1999 *Subtropical and Temperate Fruit Production*. CABI, Publications.

W S Dhillon. 2013. *Fruit Production In India*. Narendra Publishing House. New Delhi

FRS-221 Plantation Crops 3 (2+1)

Theory

History and development, scope and importance, area and production, export and import potential, role in national and state economy, uses, industrial importance, by-products utilization, soil and climate, varieties, propagation: principles and practices of seed, vegetative and micro-propagation, planting systems and method, gap filling, systems of cultivation, mulching, shade regulation, weed and water management, training, pruning and handling, nutrition, foliar feeding, role of growth regulators, soil management, liming practices, tipping practices, top working, physiological disorders, harvesting, post-harvest handling and processing, packaging and marketing, yield and economics of coconut, arecanut, oil palm, palmyrah palm, cacao, cashew nut, coffee, tea, Date palm and rubber.

Practical

Description and identification of coconut varieties, selection of coconut and arecanut mother palm and seed nut, planting of seed nuts in nursery, layout and planting of coconut, arecanut, oil palm, cashew nut, cacao gardens, manuring, irrigation; mulching, raising masonry nursery for palm, nursery management in cacao. Description and identification of species and varieties in coffee, harvesting, grading, pulping, fermenting, washing, drying and packing of coffee, seed berry collection, seed extraction, treatment and sowing of coffee, epicotyl, softwood, grafting and top working in cashew, working out the economics and project preparation for coconut, arecanut, oil palm, cashew nut, cacao, etc. Mother plant selection, preparation of cuttings and rooting of tea under specialized structure, training, centering, pruning, tipping and harvesting of tea.

Suggested Reading:

Kumar, N.J.B. M. Md. Abdul Khaddar, Ranga Swamy, P. and Irrulappan, I. 1997. *Introduction to spices, Plantation crops and Aromatic plants*. Oxford & IBH, New Delhi.

Thampan, P.K. 1981.*Hand Book of Coconut Palm*. Oxford IBH, New Delhi.

Nair 1979. *Cashew*. CPCRI, Kerala

Wood, GAR, 1975. *Cacao*. Longmen, London

Ranganadhan, V. 1979. *Hand Book of Tea Cultivation*. UPASI Tea Research Station, Cinchona.

Thompson, P.K. 1980. *Coconut.* Oxford & IBH Publishing Co. Ltd., New Delhi.

T.K. Bose, J. Kabir, P.P. Joy and P. Das (2000) Tropical Horticulture, Vol. II, Naya Prokash, Kolkata

FRS- 222 **Breeding of Fruit and Plantation Crops** **3 (2+1)**

Theory

Fruit breeding- History, importance in fruit production, distribution, domestication and adaptation of commercially important fruits, variability for economic traits, breeding strategies, clonal selection, bud mutations, mutagenesis and its application in crop improvement – **ploidy** manipulations – *in vitro* breeding tools (important fruit and plantation crops).

Practical

Exercises on floral biology, pollen viability; emasculation and pollination procedures; hybrid seed germination; raising and evaluation of segregating populations; use of mutagens to induce mutations and polyploidy in major crops like Mango, Banana, Citrus, Grapes, Guava, Sapota, Papaya, Custard apple, Aonla, Ber, Litchi, Pomegranate, Jamun, Arecanut, Coconut, **Cashewnut**, Apple, Pear, Plum, Peach, Apricot and Strawberry.

Suggested Reading:

Nijar 1985. *Fruit breeding in India*,Oxford & IBH Publishing Co., New Delhi
Anil Kumar Shukla 2004. *Fruit breeding approaches and Achievements,* IBDH, Lucknow.
Kumar, N. 1997. *Breeding of Horticultural Crops, Principles and Practices*. New India Publishing Agency, New Delhi.
Singh, B.D. 1983.*Plant Breeding Principles and methods*. Kalyani Publishers, New Delhi.

FRS-311 **Orchard and Estate Management** **2(1+1)**

Theory

Orchard and estate management, importance, objectives, merits and demerits, clean cultivation and **use of herbicides**, sod culture, sod mulch, inorganic and organic mulches. Tropical, sub-tropical and temperate horticultural systems, competitive and complimentary effect of root and shoot systems. Biological efficiency of cropping systems in horticulture, systems of irrigation. Soil management in relation to nutrient and water uptake and their effect on soil environment, moisture, organisms and soil properties. **Causes and remedies of unfruitfulness**. Rejuvenation of old orchards, top working, frame working, Integrated nutrient and pest management. **Training and pruning of fruit plants**. Crop model and crop regulation in relation to **fruit orchard**. Climate aberrations and mitigation measures of Horticultural crops.

Practical

Layout of different systems of orchard and estate, soil management, clean, inter, cover and mixed cropping, fillers. Use of mulch materials, organic and inorganic, moisture conservation, weed control. Layout of various irrigation systems.

Suggested Reading:

Kumar, 1990. *Introduction to Horticulture crops*. Rajyalakshmi Publications, Nagercoil, Tamilnadu.

Palaniappan, S.P. and Sivaraman, K. 1996. *Cropping systems in the Tropics*. New age International (P) Ltd., Publishers, New Delhi.

Shanmugavelu, K.G.1989. *Production Technology of Fruit Crops*. Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi.

W. S. Dhillon and Bhatt. 2011. *Fruit Tree Physiology*. Narendra Publishing House, New Delhi.

B .C. Mazumdar. 2004. *Principles and Methods of Orchard Establishment*. Daya Publishing House, New Delhi.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural Crops*. New India Publishing Agency, New Delhi.

B .C. Mazumdar. 2004. *Orchard Irrigation and Soil Management Practices* Daya Publishing Agency, New Delhi. Daya Publishing Agency, New Delhi.

FRS-312 Weed Management in Horticultural Crops 2 (1+1)

Theroy

Weeds: Introduction, harmful and beneficial effects, classification, propagation and dissemination; Weed biology and ecology, crop weed association, crop weed competition and allelopathy. Concepts of weed prevention, control and eradication; Methods of weed control: physical, cultural, chemical and biological methods. Integrated weed management; Herbicides: advantages and limitation of herbicide usage in India, Herbicide classification, formulations, methods of application; Introduction to Adjuvants and their use in herbicides; Introduction to selectivity of herbicides; Compatibility of herbicides with other agro chemicals; Weed management in major horticultural crops, shift of weed flora in cropping systems, aquatic and problematic weeds and their control.

Practical

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; 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; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Suggested reading:

Crafts, A.S. and Robbins, W.W. 1973. *Weed Control*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.

Gupta, O.P. 1984. *Scientific Weed Management*. Today and Tomorrow Printers and Publishers, New Delhi.

Gupta, O.P. 2015. *Modern Weed Management*. Agro Bios (India), Jodhpur.

Naidu, V.S.G.R., *Handbook of Weed Identification*. Directorate of Weed Research, Jabalpur.

Rajagopal, A., Aravindan, R. and Shanmugavelu, K.G., 2015. *Weed management of Horticultural Crops.* Agrobios (India), Jodhpur.

Ramamoorthy, K. and Subbian, P., *Predominant Weed flora in hill –ecosystems*. Agrobios (India), Jodhpur.

Rao, V.S. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co., New Delhi.

Subramanian, S., Mohammed Ali, A. and Jayakumar, R. 1991. *All About Weed Control*. Kalyani Publishers, Ludhiana.

Tadulingam, C. and Venkatnarayana, D. 1955. *A Handbook of Some South Indian Weeds.* Government Press, Madras.

Thakur, C. 1977. *Weed Science*. Metropolitan Book Co. Pvt. Ltd., New Delhi.

FRS-321 Dryland Horticulture 2 (1+1)

Theory

Definition, importance and limitation of dryland horticulture, present status and future scope. Constraints encountered in drylands. Agro-climatic features in rain shadow areas, scarse water resources, high temperature, soil erosion, run-off losses, etc.

Techniques and management of dry land horticulture. watershed development, soil and water conservation methods-terraces, contour bunds, etc. Methods of control and impounding of run-off water-farm ponds, trenches, macro catch pits, etc., *in-situ* water harvesting methods, micro catchment, different types of tree basins etc. Methods of reducing evapotranspiration, use of shelter belts, mulches, antitranspirants, growth regulators, etc. water use efficiency-need based, economic and conjunctive use of water, micro systems of irrigation etc.

Selection of plants having drought resistance. Special techniques, planting and after care-use of seedling races, rootstocks, *in-situ* grafting, deep pitting/planting, canopy management etc.

Characters and special adaptation of crops: ber, aonla, annona, jamun, wood apple, bael, pomegranate, carissa, date palm, phalsa, fig, west Indian cherry and tamarind.

Practical

Study of rainfall patterns. Contour bunding/trenching, micro catchments, soil erosion and its control. Study of evapotranspiration, mulches and micro irrigation systems. Special techniques of planting and aftercare in dry lands. Study of morphological and anatomical features of drought tolerant fruit crops.

Suggested reading:

Chundawat, B.S. 1990. *Arid Fruit Culture*. Oxford and IBH, New Delhi.

P.L. Saroj, B.B. Vashishtha and D.G. Dhandar. 2004. *Advances in Arid Horticulture*. Internal Book Distributing Co., Lucknow.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Sathesan. 2008. *Management of Horticultural Crops*. New India Publishing Agency. New Delhi

J V S Murthy (1998) Watershed Management, New Age International, New Delhi

Singh, R.P. (2016) Sustainable Development of Dryland Agriculture in India, Scientific Publishers, Jodhpur

VEG-121 Summer Vegetable Crops 3(2+1)

Theory

Area, production, economic importance and export potential of tropical and sub-tropical vegetable crops. Description of varieties and hybrid, climate and soil requirements, seed rate, preparation of field, nursery practices; transplanting and planting for directly sown/transplanted

vegetable crops. Spacing, planting systems, water and weed management; nutrient management and deficiencies, use of chemicals and growth regulators. Cropping systems, **harvesting**, yield, post-harvest handling, economics and marketing of tropical and sub-tropical vegetable crops such as tomato, brinjal, chillies, capsicum, okra, amaranthus, cluster beans, cowpea, lab-lab, snap bean, cucurbits, moringa, portulaca, basella, sorrel and roselle.

Practical

Identification and description of tropical and sub-tropical vegetable crops; nursery practices and transplanting, preparation of field and sowing/planting for direct sown and planted vegetable crops. Herbicide use in vegetable culture; top dressing of fertilizers and intercultural; use of growth regulators; identification of nutrient deficiencies. Physiological disorder. Harvest indices and maturity standards, post-harvest handling and storage, marketing, seed extraction (cost of cultivation for tropical and sub-tropical vegetable crops), project preparation for commercial cultivation.

Suggested Reading:

S. Thamburaj, 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi

B.R.Choudhary, 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.

T.K.Bose, 2002.*Vegetable Crops*. Nayaprakash. Kolkata

P.Hazra, 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.

T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.

K.V.Kamath, 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur

M.S.Dhaliwal, 2008. *Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana

Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.

K S Yawalkar, 2008. *Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur. 2004

M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana

P.Hazra, 2006.*Vegetable science*. Kalyani Publishers. Ludhiana

Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur

Uma Shankar,2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.

Nath Prem, 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi

K.L.Chadha, 1993. *Advances in Horticulture*. Malhotra publishing house. New Delhi

Shanmugavelu, K.G., 1989. *Production Technology of Vegetable Crops*. Oxford &IBH Publishing Co. Pvt. Ltd, New Delhi.

Choudhury, B. (ICAR). 1990. Vegetables. 8th edition, National Book Trust, New Delhi.

Singh, D.K., 2007. *Modern Vegetable varieties and production*. IBN publishers, Technology International Book Distributing Co, Lucknow.

Premnath, Sundari Velayudhan and Singh, D.P., 1987. *Vegetables for the tropical region*. ICAR, New Delhi.

VEG-211 Winter Vegetable Crops 2(1+1)

Theroy

Importance of cool season vegetable crops in nutrition and national economy. Area, production, export potential, description of varieties and hybrids, origin, climate and soil, production technologies, post-harvest technology and Marketing of cabbage, cauliflower, knol-khol, sprouting broccoli, Brussels' sprout, lettuce, palak, Chinese cabbage, spinach, garlic, onion, leek, radish, carrot, turnip, beet root, peas, broad beans, rhubarb, asparagus, globe artichoke, Vegetable kale.

Practical

Identification and description of varieties/hybrids; propagation methods, nursery management; preparation of field, sowing/transplanting; identification of physiological and nutritional disorders and their corrections; post-harvest handling; cost of cultivation and field visits to commercial farms.

Suggested Reading:

S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.

B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.

T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata

P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.

T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.

K.V.Kamath. 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur

M.S.Dhaliwal, 2008.*Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana

Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.

K S Yawalkar, 2004.*Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.

M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana

P.Hazra. 2006.*Vegetable science*. Kalyani Publishers .Ludhiana

Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur

Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.

Nath Prem. 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi

K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi

Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.

Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.

Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.

Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

VEG-212 Precision Farming& Protected Cultivation 3 (2+1)

Theroy

Precision farming – laser leveling, mechanized direct seed sowing; seedling and sapling transplanting, mapping of soils and plant attributes, site specific input application, weed management, insect pests and disease management, yield mapping in horticultural crops. Green house technology, Introduction, Types of Green Houses; Plant response to Greenhouse environment, Planning and design of greenhouses, Design criteria of greenhouse for cooling and heating purposes. Green house equipment, materials of construction for traditional and low cost green houses. Irrigation systems used in greenhouses, Typical applications, passive solar green house, hot air greenhouse heating systems, green house drying. Cost estimation and economic analysis. Choice of crops for cultivation under greenhouses, problems / constraints of greenhouse cultivation and future strategies. Growing media, soil culture, type of soil required, drainage, flooding and leaching, soil pasteurization in peat moss and mixtures, rock wool and other inert media, nutrient film technique (NFT) / hydroponics.

Practical

Study of different types of greenhouses based on shape, construction and cladding materials; Calculation of air rate exchange in an active summer winter cooling system; Calculation of rate of air exchange in an active winter cooling system; Estimation of drying rate of agricultural products inside green house; Testing of soil and water to study its suitability for growing crops in greenhouses; The study of fertigation requirements for greenhouses crops and estimation of E.C. in the fertigation solution; The study of various growing media used in raising of greenhouse crops and their preparation and pasteurization / sterilization; Visit to commercial green houses; Economics of protected cultivation.

Suggested Reading:

Balraj Singh. 2006. *Protected cultivation of vegetable crops*. Kalyani Publishers, Ludhiana.

Brahma Singh, 2014.*Advances in Protected Cultivation*. New India Publishing Agency. New Delhi.

Reddy P. Parvatha, 2003. *Protected Cultivation*. Springer Publications. USA.

Reddy, P. Parvatha. 2011. *Sustainable crop protection under Protected Cultivation*. Springer Publications. USA.

Jitendra Singh, 2015.*Precision Farming in Horticulture*. New India Publishing Agency. New Delhi.

Prasad S. 2005. *Greenhouse Management for Horticultural Crops*. Agrobios. Jodhpur.

Jitendra Singh, S.K. Jain, L.K. Dashora, B.S. Cundawat.2013. *Precision forming in Horticulture*. New India Publishing Agency, New Delhi.

T. Pradeep Kumar, B. Suma, Jyothi Bhaskar and K.N.Satheson. 2008. *Management of Horticultural crops*. New India Publishing Agency, New Delhi.

Aldrich RA & Bartok JW. 1994. NRAES,Riley, Robb Hall. *Green House Engineering*. Cornell University, Ithaca, New York.

Pant V Nelson. 1991.*Green House Operation and Management*. Bali Publ

VEG-221 Spices and Condiments 3(2+1)

Theory

History, scope and importance, Present status, area and production, uses, export potential and role in national economy. Classification, soil and climate, propagation-seed, vegetative and micropropagation systems and methods of planting. Nutritional management, irrigation practices, weed control, mulching and cover cropping. Training and pruning practices, role of growth regulators, shade crops and shade regulation. Harvesting, post-harvest technology, packaging, storage, value added products, methods of extraction of essential oil and oleoresins. Economics of cultivation, role of Spice Board and Pepper. Export Promotion Council, institutions and research centers in R&D. Crops: Cardamom, black pepper, betel vine ginger, turmeric, clove, nutmeg, cinnamon, all spice, curry leaf, coriander, fenugreek, fennel, cumin, dill, celery, bishops weed, nigella, saffron, vanilla, thyme and rosemary.

Practical

Identification of varieties: propagation, seed treatment – sowing; layout, planting; hoeing and earthing up; manuring and use of weedicides, training and pruning; fixing maturity standards, harvesting, curing, processing, grading and extraction of essential oils and oleoresins. Visit to commercial plantations.

Suggested Reading:

Shanmugavelu, K.G. Kumar, N and Peter, K.V., 2005. *Production technology of spices and plantation crops*. . Agrosis, Jodhpur

Shanmugavelu, K.G. and Madhava Rao, 1977. *Spices and Plantation Crops*. Madras Popular Book Depot.

Kumar, N. J.B. M. Md. Abdul khaddar, Ranga Swamy, P. and Irulappan, I., 1997. *Introduction to Spices, Plantation Crops, and aromatic crops*. Oxford & IBH, New Delhi.

Pruthi, J.S., 1980. *Spices and Condiments*. Academic Press, New York.

Pruthi, J.S., 1993. *Major Spices of India- Crop Management Postharvest Technology*. ICAR, New Delhi.

Pruthi, J.S., 2001. *Minor Spices and Condiments-Crop ManagementPost Harvest Technology.* ICAR, New Delhi.

Purseglove, Brown, E.G. Green, G.Z. Robbins, S.R.J. London, Longman, 1981. *Spices* Vol.I & II.

VEG-311 Potato and Tuber Crops 2 (1+1)

Theroy

Origin, area, production, economic importance and export potential of potato and tropical, sub-tropical and temperate tuber crops; description of varieties and hybrids. Climate and soil requirement, season; seed rate; preparation of field; planting practices; spacing; water, nutrient

and weed management; nutrient deficiencies. Use of chemicals and growth regulators; cropping systems. Harvesting practices, yield; economic of cultivation. Post- harvest handling and storage, field and seed standards, marketing. Crops to be covered – potato, sweet potato, arrow root, cassava, colocasia, xanthosoma, amorphophallus, dioscorea, Jerusalem artichoke, horse radish and other under exploited tuber crops.

Practical

Identification and description of potato and tropical, sub-tropical and temperate tuber crops; planting systems and practices; field preparation and sowing/planting. Top dressing of fertilizers and interculture and use of herbicides and growth regulators; identification of nutrient deficiencies, physiological disorders; harvest indices and maturity standards, post-harvest handling and storage, marketing. Seed collection, working out cost of cultivation, project preparation of commercial cultivation.

Suggested reading:

S. Thamburaj. 2014. *Text book of vegetable, tuber crops and Spices*. ICAR, New Delhi.

B.R.Choudhary 2009.*AText book on production technology of vegetables*. Kalyani Publishers. Ludhiana.

T.K.Bose. 2002.*Vegetable Crops*. Nayaprakash. Kolkata

P.Hazra. 2011. *Modern Technology in Vegetable Production*. New India Publishing Agency. New Delhi.

T.R.Gopal Krishnan, 2007. *Vegetable Crops*. New India Publishing Agency. New Delhi.

K.V.Kamath. 2007.*Vegetable Crop Production*. Oxford Book Company. Jaipur

M.S.Dhaliwal, 2008.*Handbook of Vegetable Crops*. Kalyani Publishers. Ludhiana

Singh, Umashankar, 2008. Indian Vegetables. Anmol Publications. Pvt.Ltd .New Delhi.

K S Yawalkar, 2004.*Vegetable crops in India*. Agri-Horticultural Pub. House. Nagpur.

M.K.Rana, 2008.*Olericulture in India*. Kalyani Publishers. Ludhiana

P.Hazra. 2006.*Vegetable science*. Kalyani Publishers .Ludhiana

Pratibha Sharma, 2007.*Vegetables : Disease Diagnosis and Biomanagement*. Avishkar Publishers. Jaipur

Uma Shankar. 2008. *Vegetable Pest Management Guide for Farmers*. International Book Distribution Co. Publication. Lucknow.

Nath Prem. 1994.*Vegetables for the Tropical Regions*. ICAR New Delhi

K.L.Chadha. 1993.*Advances in Horticulture*. Malhotra publishing house. New Delhi

Shanmugavelu, K.G. 1989. Production technology of vegetable crops. Oxford and IBH publishing Co. Pvt. Ltd, New Delhi.

Bose, T.K. 2003. Vegetable Crops. Naya udyog publishers, Kolkata. 2002. Naya Prakash, Calcutta.

Prem Singh Arya, 1999. Vegetable Seed Production Principles. Kalyani Publishers, New Delhi.

Choudhery, B., 1990. Vegetables. 8th edition. National Book Trust, New Delhi.

Vincent Lebot, 2008.*Tropical roots and tuber crops*. CAVI.

J.E. Bradashaw, 2010. Root and tuber crops. Springer Publications.

VEG-321 Breeding of Vegetable, Tuber and Spice Crops 3(2+1)

Theory

Breeding objectives and important concepts of breeding self pollinated, cross pollinated and vegetatively propagated crops. Plant genetic resources, their conservation and utilization in crop improvement. Breeding for insect resistance, breeding for disease resistance, breeding for abiotic resistance, male sterility and incompatibility and their utilization in development of hybrids. Origin, distribution of species, wild relatives and forms of vegetable crops Tomato, Brinjal, Okra, Chilli, Cucurbits, Cabbage, Cauliflower, Tuber crops (Potato, Sweet potato, Cassava), Carrot, Radish, Spice crops (Ginger, Turmeric, Coriander, Fenugreek), bulb (onion & garlic), legume (pea and French bean). Breeding procedures for development of hybrids/varieties in various crops. Genetic basis of adoptability and stability.

Practical

Floral biology and pollination mechanism in self and cross pollinated vegetables, tuber crops and spices. Working out phenotypic and genotypic heritability, genetic advance. GCA, SCA, combining ability, heterosis, heterobeltosis, standard heterosis, GxE interactions (stability analysis) Preparation and uses of chemical and physical mutagens. Polyploidy breeding and chromosomal studies. Techniques of F1 hybrid seed production. Maintenance of breeding records.

Suggested Reading:

Hari Hara Ram, 2013.*Vegetable Breeding: Principle and Practices*. Kalyani Publishers. Ludhiana.

Vishnu Swaroop, 2014. *Vegetable Science &Technology in India*. Kalyani Publishers. Ludhiana.

Kallo.G, 1998. *Vegetable Breeding (Vol.I to IV).* CRC Press. Florida. 1988.

H.P. Singh, 2009.*Vegetable Varieties of India*. Studium Press (India) Pvt Ltd. New Delhi.

M.S. Dhaliwal.2012**.** *Techniques of Developing Hybrids in Vegetable Crops***.**Agrobios. Jodhpur.

P.K.Singh, 2005. *Hybrid Vegetable Development*. CRC Press. Florida.

M.S.Dhaliwal, 2009. *Vegetable Seed Production & Hybrid Technology*. Kalyani Publishers. Ludhiana.

Fageria, M.S., 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers, Ludhiana

VEG-322 Seed Production of Vegetable, Tuber and Spice Crops 3(2+1)

Theory

Introduction and history of seed industry in India. Importance and scope of vegetable seed production in India. Definition of seed, classes-types of seed. Differences between grain and seed. Principles of vegetable seed production. Role of temperature, humidity and light in vegetable seed production, land requirements, climate, season, planting time, nursery management, seed rate, rouging, seed extraction and storage of cole crops, root vegetables, solanaceous vegetables, cucurbits, okra, leafy vegetables, bulb crops, leguminous vegetables and exotic vegetables. Seed germination and purity analysis. Field and seed standards. Seed drying and extraction. Seed legislation.

Practical

Study of seed structure, colour size, shape and texture. Field inspection of seed crops. Practices in rouging. Harvesting and seed extraction. Germination and purity analysis. Methods of seed production, Seed certification in cole crops, root vegetables, bulb crops, solanaceous vegetables, cucurbits, okra, leafy vegetables, leguminous vegetables and exotic vegetables. Seed processing machines. Visit to seed production units.

Suggested Reading:

G.N. Kulkarni, 2002. *Principles of Seed Technology*. Kalyani Publishers, Ludhiana.

L.O. Copeland, 1999. *Principles of Seed Science and Technology*. Springer Publications.

N.P. Nema, 1988. *Principles of seed certification and Testing*. Allied Publications.

P. Hazra and M.G. Som, 2009. *Vegetable seed production and Hybrid Technology*. Kalyani Publishers, Ludhiana.

Agarwal, P. K. 2010. *Techniques in Seed Science and Technology*. South Asian Publishers. New Delhi.

Agrawal R. L. 1999. *Seed Technology*. Oxford and IBH Publicity Company, New Delhi.

Arya, Prem Singh. 2003. *Vegetable seed Production Principles*. Kalyani Publishers. Ludhiana.

Fageria, M. S. 2011. *Vegetable Crops- Breeding and Seed Production*. Kalyani Publishers. Ludhiana.

Geetharani, P. 2007. *Seed Technology in Horticultural Crops*. NPH Publications. Jodhpur.

Singh, S.P. 2001. *Seed Production in Commercial Vegetables*. Agrotech Publishing Academy, Udaipur.

Vanangamudi, K.2010. *Vegetable Hybrid Seed Production and Management*. Agrobios. Jodhpur.

Singh, Prabhakar.2015.*Seed Production Technology of vegetable*. Daya Publishing House. New Delhi.

Raymond A.T., 2000. *Vegetable Seed Production*. Oxford University Press, USA

Prem Singh Arya, 2003. *Vegetable breeding, production and seed production*. Kalyani publishers, New Delhi.

Rattan lal Agarwal, 1995. *Seed technology*. Oxford & IBH, New Delhi

Singh, S.P. 2001. 1st edition, *Seed production of commercial vegetables*. Agrotech Publishing, Udaipur

Vanangamudi, K. 2006. Natarajan, P. Srimathi, N.Natarajan, T. Saravanan, M. Bhaskaran, A. Bharathi, P. Nateshan, K. Malarkodi. *Advances in Seed Science*. Agrobios (India), Jodhpur.

Nemgal Singh, P.K. Singh, Y.K. Singh and Virendra kumar, 2006. *Vegetable Seed Production Technology*. International book distributing co., Lucknow.

Khare, D. and Bhole, M.S. 2000. *Seed Technology*. Scientific Publishers (India) Jodhpur

FLS- 121 Principles of Landscape Architecture 2(1 +1)

Theory:

Historical importance of Indian gardens, gardens of ancient world, definitions, famous gardens of India and abroad; formal, informal, free style and wild gardens. Basic themes of gardens *viz.* circular, rectangular and diagonal themes. Steps in preparation of garden design. Use of Auto-CAD and Arch-CAD in designing gardens. Factors affecting landscape design *viz.* initial approach, view, human choice, simplicity, topography, etc. Principles of landscape gardens *viz.* axis, rhythm, balance, time and light, space, texture, form, mass effect, focal point, mobility, emphasis, unity and harmony, etc. Elements of landscape gardens *viz.* tangible and intangible elements. Bio-aesthetic planning- definition and objectives. Planning and designing of home gardens, colonies, country planning, urban landscape, institutional gardens, planning and planting of avenues, beautifying schools, railway lines, railway stations, factories, bus stands, air ports corporate buildings, dams, hydro electric stations, river banks, play grounds, gardens for places of religious importance *viz.* temples, churches, mosques, tombs, etc. Importance and features of English gardens, Japanese gardens, Mughal gardens, French and Persian gardens, Italian gardens, Hindu gardens and Buddhist gardens. Xeriscaping- definition, principles and practices.

Practical:

Study of garden equipments. Study of graphic language, symbols and notations in landscape designing. Use of drawing equipments. Study and designing of different styles of gardens. Study and designing of gardens based on different themes. Designing gardens using Auto-CAD/Archi-CAD. Designing gardens for home, institutes and public places. Designing and planting of avenues for state and National highways. Designing of Japanese, English and Mughal gardens. Visit to public, institutional and botanical gardens.

FLS- 211 Commercial Floriculture 3 (2+1)

Theory:

Scope and importance of commercial floriculture in India. Production techniques of commercial flower crops *viz.* rose, marigold, chrysanthemum, orchid, carnation, gladiolus, jasmine, **gaillardia**, anthurium, dahlia, tuberose, bird of paradise, china aster and gerbera for domestic and export markets. Production techniques of flowers and foliage filler materials *viz.* asparagus, *Murraya penniculata* and cycus. Growing of flowers under protected environments ***viz.*** **rose, chrysanthemum, anthurium, carnation and gerbera**. Postharvest technology of commercial cut flower crops. Dehydration techniques for drying of flowers. Production techniques for bulbous **plants *viz.* tulip, amaryllis, spider lily and crinum.**

Practical:

Identification of commercially important floricultural crops. Propagation practices in **major flower crops**. Sowing of seeds and raising of seedlings of annuals. Propagation by cutting, layering, budding and grafting. Training and pruning of roses. Use of chemicals and other compounds for prolonging the vase life of cut flowers. Drying and preservation of flowers. Flower arrangement practices.

FLS- 221 Ornamental Horticulture 3(2+1)

Theory:

History and scope of ornamental horticulture, definitions and aesthetic values. Floriculture industry- importance, area and production, industrial importance of ornamental plants and flowers. Importance, classification, design values and general cultivation aspects for ornamental plants *viz*. annuals, biennales, herbaceous perennials, grasses and bulbous ornamentals, shrubs, climbers, trees, indoor plants, palms and cycads, ferns and sellagenellas, cacti and succulents. Importance and design values of garden features/components *viz.* hedge, edge, borders, flower beds, bridges, drives, paths, fences, garden walls, gates, carpet bed, arbour, patio, decking, retaining walls, shade garden, sunken garden, roof garden, terrace garden, pebble garden, rockery, pools, waterfalls, fountains, bog garden, avenue planting and children garden. Lawn- establishment and maintenance. Importance of garden adornments *viz.* floral clock, bird bath, statues, sculptures, lanterns, water basins, garden benches, etc. Importance of flower arrangement; Ikebana- types, suitable flowers and foliages. Uses of vertical garden, bottle garden and terrarium. Bonsai- styles, culture and maintenance.

Practical:

Identification and description of annuals, biennials, herbaceous perennials, climbers, shrubs, trees, indoor plants, ferns and sellagenellas, palms and cycads and cacti and succulents. Planning and designing of garden features *viz.* lawn, hedge and edge, rockery, water garden, carpet bedding and shade garden. Study and creation of terrarium and vertical garden. Study and practice of different types of flower arrangements, preparation of floral bouquets, preparation of floral rangoli, veni, etc. Bonsai practicing and training. Visit to nurseries and floricultural units.

FLS- 311 Medicinal and Aromatic Crops 3(2+1)

Theroy

History, scope, opportunities and constraints in the cultivation and maintenance of medicinal and aromatic plants in India. Importance, origin, distribution, area, production, climatic and soil requirements, propagation and nursery techniques, planting and after care, cultural practices, training and pruning, nutritional and water requirements. Plant protection, harvesting and processing of under mentioned important medicinal and aromatic plants. Study of chemical composition of a few important medicinal and aromatic plants, extraction, use and economics of drugs and essential oils in medicinal and aromatic plants. Therapeutic and pharmaceutical uses of important species. Storage techniques of essential oils. Medicinal Plants: *Withania*, periwinkle, Rauvolfia, Dioscorea, Isabgol, opium poppy *Ammi majus*, Belladonna, Cinchona, Pyrethrum and other species relevant to local conditions. Aromatic Plants: Citronella grass, khus grass, flag (baje), lavender, geranium, patchouli, bursera, menthe, musk, occimum and other species relevant to the local conditions. Marketing.

Practical Collection of medicinal and aromatic plants from their natural habitat and study their morphological description, nursery techniques, harvesting, curing and processing techniques and extraction of essential oils.

Suggested Reading:

Chadha, K.L. ICAR, 2001. Hand Book of Horticulture. Directorate of Information and Publications of Agriculture, Pusa, New Delhi.

Azhar Ali Farooqui and Sreeramu, B.S. 2001. Cultivation of medicinal and aromatic plants. United Press Limited.

Atal, E.K. and Kapur, B. 1982. Cultivation and Utilization of Medicinal and Aromatic plants. CSIR, New Delhi.

Kumar, N. J.B.M. Md. Abdul Khaddar, Ranga Swamy, P. and Irulappan, I. 1997. Introduction to Spices, Plantation Crops Medicinal and Aromatic Plants.Oxford & IBH, New Delhi.

Jain, S.K. 1968. Medicinal Plants .National Book Trust New Delhi. Oxford & IBH, New Delhi.

Dastur, J.F. 1982. Medicinal plants of India Pakistan Taraprevala soms and co-private Ltd, Bombay

FLS- 321 Breeding and Seed Production of Flower and Ornamental Crops 3(2+1)

Theory:

History of improvements of ornamental plants. Centres of origin of flower and ornamental crops. Objectives and techniques in ornamental plant breeding. Introduction, selection, hybridization, mutation and biotechnological technique for improvement of ornamental and flower crops *viz*., Rose, Jasmine, Chrysanthemum, Tuberose, Gerbera, Gladiolus, Dahlia, Heliconia, Lilium, Gaillardia, Petunia, Hibiscus, Bougainvillea, Zinnia, Cosmos, Dianthus, Snapdragon, Pansy, Marigold, Antirrhinum, China aster, **Amaryllis, Zephyranthes, Spider lily and Balsam**. Breeding for disease resistance. Development of promising cultivars of important flower and ornamental crops. Role of heterosis and its exploitation. Production of F_1 hybrids and utilization of male sterility. Production of open pollinated seed. Harvesting, processing and storage of seed. Seed certification.

Practical:

Study of floral biology and pollination in important species and cultivars. Techniques of inducing polyploidy and mutation. Production of pure and hybrid seeds. Harvesting, conditioning and testing of seed. Practice in seed production methods.

Suggested Reading:

B.P. Pal. *The Rose in India*.1966.Directorate of Knowledge management in Agriculture, Indian council of Agriculture Research-New Delhi.

T.K. Bose, L.P. Yadav, P. Patil, P. Das and V.A. Partha Sarthy. 2003. *Commercial flowers.* Partha Sankar Basu, Nayaudyog, 206, Bidhan Sarani, Kolkata-700006.

S.K. Bhattacharjee and L.C. De. 2003. *Advanced Commercial Floriculture*. Aavishkar Publishers, Distributors, Jaipur (Rajasthan) India.

D.J. Callaway and M.B. Callaway. 2000. Breeding Ornamental Plants. Timber Press

J. Harding, F.Singh and J.N. Mol. 1991. Genetics and Breeding of Ornamental Species. Springer Publishers

A. Vainstein. 2002. Breeding for Ornamental: Classical and Molecular Approaches. Springer Publishers

Singh,B.D. 1983. BreedingPrinciplesandMethods. KalyaniPublishers,NewDelhi.

R.L. Agarwal. 1996. Seed Technology. Oxford&IBHPublishers, New Delhi

P.K. Agarwal. 1994. Principles of Seed Technology. ICAR Publication, NewDelhi

PHT- 121 FUNDAMENTALS OF FOOD TECHNOLOGY AND NUTRITION 2(1+1)

Theory:

Food and its function, physico-chemical properties of foods, food preparation techniques. Nutrition, relation of nutrition to good health. Role of fruits and vegetables in human nutrition. Energy: definition, determination of energy requirements, food energy and total energy needs of the body. Carbohydrates: functions, source, requirements, digestion, absorption and utilization. Protein: functions, sources, requirements, digestion, absorption, essential and non-essential amino acids, quality of proteins, PER/NPR/NPU, supplementary value of proteins and deficiency. Lipids: functions, sources, requirements, digestion, absorption and utilization, saturated and unsaturated fatty acids, deficiency. Mineral nutrition: macro and micro-minerals (Ca, Fe and P), function, utilization, requirements, sources, effects of deficiency. Vitamins: functions, sources, effects of deficiency, requirements of water soluble and fat-soluble vitamins. Balanced diet: recommended dietary allowances for various age groups, common disorders due to malnutrition in population, assessment of nutritional status of the population.

Practical:

Acquaintance with equipments used in food technology, Methods of measuring food ingredients, effect of cooking on volume and weight, determination of percentage of edible portion. Browning reactions of fruits and vegetables. Microscopic examination of starches, estimation of energy value, quality of protein and fats content of foods. Planning diet for various age groups. Survey of population for nutritional status.

Suggested Readings:

1. Jain, S.K. 2010. *Teaching manual on fundamentals of foods and nutrition*. CH&F, Jhalawar 72p.
2. Manay, N. Shakuntala and Shadaksharaswamy, M. *Foods: Facts & Principles,* New Age International (P) Limited Publishers, New Delhi.
3. Mudambi, Sumati R. and Rajagopal, M.V. *Fundamentals of Foods & Nutrition, Third Edition,* New Age International (P) Limited Publishers, New Delhi.
4. Potter, Norman N. and Hotchkiss, Joseph H. *Food Science, Fifth Edition*, CBS Publishers & Distributors, New Delhi.

PHT- 311 POSTHARVEST MANAGEMENT OF HORTICULTURAL CROPS 3(2+1)

Theory:

Importance & scope of post-harvest management of horticultural crops in India. Maturity indices, harvesting, pre cooling, sorting and grading of fruit, vegetables, cut flowers, medicinal and aromatic plants. Pre-harvest factors affecting quality. Factors responsible for deterioration of horticultural produce. Physiological and bio-chemical changes during ripening. Hastening and delaying ripening process. Pre and Post harvest treatments of Horticultural crop viz. pre harvest sprays, curing, degreening, pre cooling, waxing, fumigation, irradiations, VHT, etc. Quality parameters and specification. Structure of fruits, vegetables and cut flowers related to physiological changes after harvest. Different systems of storage including cold storage, CA & MA storage, low cost cooling structures, etc. Packaging, pre packaging treatments, types of

packages, types of cushioning materials, vacuum packaging, , poly shrink packaging, grape guard packing . Transportation of fresh horticultural produce to local and export market.

Practical:

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, Packaging studies in fruits, vegetables and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in horticultural crops. Visit to markets, pack houses and cold storage units.

Suggested Readings:

1. Jain, S.K. and Dashora, L.K. 2012. *Practical Manual on Post harvest handling of horticultural produce.* CH&F, Jhalawar p.
2. Pantastico. B. 1975. *Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables,* AVI Publishing Company, Inc.
3. S. K. Mitra. Post Harvest Physiology and storage of tropical and subtropical fruits, CABI Publishing.
4. Saraswathy,S., Preethi,T.L., Balasubramanyan, S., Suresh, J., Revathy, N. and Natarajan, S. 2008. *Post Harvest Management of Horticultural Crops,* Agribios (India), Jodhpur.
5. Thompson, A.K. *Post Harvest Technology of fruits and vegetables*, Blackwell Science.
6. Wills, R.B.H., McGlasson, W.B., Graham, D., Lee, T.H. and Hall, E.G. 1996. *Post Harvest: An Introduction to the Physiology and Handling of Fruits and vegetables,* CBS Publishers and Distributors, New Delhi.

PHT-321 PROCESSING OF HORTICULTURAL CROPS 3(1+2)

Theory:

Importance and scope of fruit and vegetable preservation industry in India. Food pipe line, unit operations in food processing. General principles of preservation of fruits and vegetables.

Preservation by heat, pasteurization and sterilization , canning and bottling of fruits and vegetables. Unit operations in canning, containers and equipments used.

Preservation by chemical preservatives, Preparation and preservation of unfermented beverages viz. juices, RTS, nectar, squashes, syrups, cordials and fermented beverages viz. wine, champagne etc.

Preservation by sugar, Jam, jelly and marmalade, preserves, candies, crystallized fruits etc.

Preservation with salt, spices, oil and vinegar, pickling, chutneys and tomato products. Preservation by Freezing, Drying & dehydration of fruits & vegetables, spoilage in processed foods, quality control of processed products, Govt. policy on import and export of processed fruits. Food laws. Principles and guidelines for the establishment of processing units.

Practical:

Equipment and containers/ packaging material used in food processing. Canning of fruits and vegetables, preparation of juice, squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles. Tomato products, dehydration and freezing, Visit to processing units. Quality control of processed products.

Suggested Readings:

1. Cruess, W.V. 1958. *Commercial fruit and vegetable products*. Mc Graw Hill Book Co. Inc, New York.
2. Kalia, Manoranjan and Sood, Sangita. *Food Preservation and Processing*, Kalyani Publishers, Ludhiana.
3. Lal, Girdhari Siddappaa, G.S. and Tandon, G.L. *Preservation of fruits & vegetables,* ICAR, New Delhi.
4. Srivastava, R.P. and Sanjeev Kumar. *Fruit & Vegetable Preservation: Principles and Practices, 3rd Edition,* International Book Distributing Co., Lucknow.

SYLLABUS

For

M.Sc. Forestry (Forest Biology and Tree Improvement)

2018-19

FACULTY OF FORESTRY

DEPARTMENT OF FOREST BIOLOGY AND TREE IMPROVEMENT

COLLEGE OF HORTICULTURE AND FORESTRY,
JHALARAPATAN, JHALAWAR
(AGRICULTURE UNIVERSITY, KOTA)

M.Sc. Forestry (Forest Biology and Tree Improvement)
Semester-wise Distribution of Courses

	Semester I	
Course Code	**Course Title**	**Credit Hours**
FORT -511	Silviculture & Forest Biometry	3 (2+1)
FORT -512	Forest Management and Protection	3 (2+1)
FORT- 513	Tree Physiology & Tree Improvement	3 (2+1)
STAT- 512	Statistical Methods and Computer Application	3 (2+1)
SAF-511	*Forests and Climate Change	3(2+1)
NRM-511	* Forest Soil and Land Reclamation	3(2+1)
SAF-512	*Ecotourism & Participatory Forestry	3(2+1)
NRM-512	*Landuse and Watershed Management	3(2+1)
	Total Credit Hours of Courses	**15(10+5)**
FORT-451 (Deficiency course)	Practices of Silviculture	3 (2+1) NC
	Semester II	
Course Code	**Course Title**	**Credit Hours**
FBT- 521	Tree Seed Orchards	3(2+1)
FBT- 522	**Reproductive Biology of Forest Trees	3 (2+1)
FBT- 523	**Quantitative Genetics in Forest Tree Breeding	3 (2+1)
FBT- 524	**Forest Botany and Seed Technology	3(2+1)
FBT-525	**Breeding Methods in Forest Trees	3 (2+1)
FBT- 526	**Forest Genetic Diversity and Conservation	3(2+1)
FBT- 527	**Forest Biotechnology	3 (2+1)
	Total Credit Hours of Courses	**12(8+4)**
PGS 502	e-course Technical Writing and Communication Skills	1(0+1) NC
FORT-452 (Deficiency course)	Forest Products and Utilization	3(2+1) NC
	Semester-III	
Course Code	**Course Title**	**Credit Hours**
FORT-531	Forest Products – Chemistry and Industries	3(2+1)
FBT- 531	Clonal Forestry	3(2+1)
FBT-532	*Forest Ecology and Biodiversity Conservation	3(2+1)
NRM-531	* Remote Sensing and Geographic Information System	3(2+1)
SAF-537	* Forests and People	3(2+1)
FBT-591	Credit Seminar	1(0+1)
	Total Credit Hours of Courses	**10(6+4)**
PGS - 503	e-course Intellectual Property and its management in Agriculture	1 (1+0) NC
PGS -506	e-course -Disaster Management	1(1+0) NC
FORT-453 (Deficiency course)	Dendrology & Forest Botany	3(2+1) NC
	Semester-IV	
Course Code	**Course Title**	**Credit Hours**
FBT-541	Comprehensive (NC)	1+0 (NC)
FBT-599	Research	**20(0+20)**
	Total Credit Hours (I+II+III-IV) (15+12+10+20)	**57**

Any one to be opted, ** Opt one from either course (only for Forest Biology and Tree Improvement students)

MASTER OF SCIENCE FORESTRY (FOREST BIOLOGY AND TREE IMPROVEMENT)
COURSES APPROVED BY THE ADVISORY COMMITTEE

CORE COURSES	FORT - 511	Silviculture & Forest Biometry	3 (2+1)
	FORT - 512	Forest Management and Protection	3 (2+1)
	FORT – 513	Tree Physiology & Tree Improvement	3 (2+1)
	FORT - 531	Forest Products – Chemistry and Industries	3 (2+1)
		Total (Core Courses)	**12(8+4)**
MAJOR COURSES	FBT -522	**Reproductive Biology of Forest Trees	3 (2+1)
	FBT -523	**Quantitative Genetics in Forest Tree Breeding	3 (2+1)
	FBT -524	**Forest Botany and Seed Technology	3 (2+1)
	FBT -525	*Breeding Methods in Forest Trees	3 (2+1)
	FBT -526	**Forest Genetic Diversity and Conservation	3 (2+1)
	FBT -527	**Forest Biotechnology	3 (2+1)
	FBT -521	Tree Seed Orchards	3 (2+1)
	FBT -531	Clonal Forestry	3 (2+1)
		** ***Any three to be opted (as per semester distribution option)***	
		Total (Major Courses)	**15(10+5)**
MINOR COURSES	STAT -512	Statistical Methods and Computer application	3 (2+1)
	FBT-532	*Forest Ecology and Biodiversity Conservation	3 (2+1)
	NRM-511	* Forest Soil and Land Reclamation	3 (2+1)
	SAF-511	*Forests and Climate Change	3 (2+1)
	NRM-531	* Remote Sensing and Geographic Information System	3 (2+1)
	NRM-512	*Landuse and Watershed Management	3 (2+1)
	SAF-512	* Ecotourism & Participatory Forestry	3 (2+1)
	SAF-537	* Forests and People	3 (2+1)
		* ***Any two courses to be opted (as per semester distribution option)***	
		Total (Minor Courses)	**9(6+3)**
NON - CREDIT COURSES	PGS 502	Technical Writing and Communication Skills	0+1(NC)
	PGS 503	e-course –Intellectual Property and its management in Agriculture	1+0(NC)
	PGS 506	e-course- Disaster Management	1+0(NC)
***NON - CREDIT DEFICIENCY COURSES	FORT- 451	Practices of Silviculture	2+1(NC)
	FORT- 452	Forest Products and Utilization	2+1(NC)
	FORT- 453	Dendrology and Forest Botany	2+1(NC)
		***Required to be offered by the students not having B.Sc. Forestry Degree Programm**	
	FBT-591	Credit Seminar	**1(0+1)**
	FBT -541	Comprehensive (NC)	1+0 (NC)
	FBT -599	Research	**20 (0+20)**
		Grand Total	**57**

Core Courses

Semester I

FORT-511 Silviculture and Forest Biometry 3 (2+1)

Objective

To provide knowledge about Forest ecosystem concept, stand dynamics-forest succession, productivity and vegetation forms and natural regeneration of tree species. To develop understanding of students about tree measurements, forest inventory and yield concepts

Theory

UNIT I

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

UNIT II

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT III

Natural regeneration of species and types including uneven aged silviculture. Intermediate treatments.

UNIT IV

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands, Preparation of volume & its application, yield and stand tables.

UNIT V

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT VI

Growth and yield prediction models – their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practice*s. Oxford and IBH.

Dwivedi AP. 1993. *A Text Book of Silvicultur*e. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silvicultur*e. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuratio*n. International Book Distributor.

Ram Parkash 1983. *Forest Surveyin*g. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestr*y. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuratio*n. Bishen Singh Mahender Pal Singh, Dehradun

FORT-512 Forest Management and Protection 3 (2+1)

Objective

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density and forest valuation. To provide knowledge to students about forest protection through diseases and pest management.

Theory

UNIT I

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT II

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies. Forest valuation and appraisal in regulated forests.

UNIT III

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management.

UNIT IV

Biodegradation of wood – microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots – factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health.

UNIT V

Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

UNIT VI

Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance trees.

Practical

Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Collection, identification and preservation of important insect pests and disease specimens of forest plants. Assessment of losses due to diseases, insect pests etc.. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in nurseries and plantations, Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection.

Suggested Readings

Ajay S Rawat. *History of Forest in India*
Avery and Burkhart. *Forest Measurement*
Brasnet, NV. *Planned Management of Forests*.
Duerra Telquarden. *Forest Resource Management*
Lawrance S. Davis and K.Morman Johson. *Forest Management*
Maslekar. *Managing the forest*
Myth D Realty by J B Lal. *India's Forests*
Oliver, CD and Larson BC. *Forest Stand Dynamics*
Osmaston. *Management of Forest*
Ram Parkash. *Forest Management,*
Sharma, LC. *Forest Economics, Planning and Management*
Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.Jha LK and Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House.
Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall.
Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.

FORT-513 Tree Physiology and Tree Improvement 3(2+1)

Objective

To acquaint the students about general principles tree physiology tree breeding with examples of important trees.

Theory

UNIT I

Introduction to tree physiology. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency.

UNIT II

Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Water relations of forest trees – Transpiration from forest canopies - Water use efficiency of forest stands. GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C, N, P, S.

UNIT III

General concept of forest tree breeding, tree improvement and forest genetics.

UNIT IV

Reproduction in forest trees, dimorphism pollination mechanism. Pollen dispersal, pollinators. Attractants for pollinators.

UNIT V

Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races.

UNIT VI

Seed, seed formation, dispersal, storage and seed dormancy.

UNIT VII

Selective breeding methods- mass, family, within family, plus within family. Plus, tree selection for wood quality,

UNIT VIII

Progeny and clone testing. Seed orchards – type, functions and importance. Estimating genetic parameters and genetic gain.

UNIT IX

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, Neem,etc.

UNIT X

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy.

UNIT XI

Biotechnology in tree improvement.

Practical:

Estimation of stomatal index. Estimation of water potential in plants using Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, and LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc. Measurement of relative water content, leaf water potential, osmotic potential Observation on tree architecture of important species Study of Floral biology of important trees in the region, Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids.

Suggested Readings

Hopkins, W.G. and Huner, N.P.A. (2008) *Introduction to plant physiology*. Wiley.

Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York

Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London

Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Managment. Academic Press Inc., London.

Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd. Singapore.

Mandal AK and Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN and Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

White TL, Adams WT and Neale DB. 2007. *Forest Genetics*. CABI, UK.

Zobel BJ and Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley and Sons.

FORT-531 Forest Products –Chemistry and Industries 3(2+1)

Objective

The course will equip the students regarding wood-based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this wood extracts resins and gums, katha, tannins and various types of non-timber products. Practical will make them aware regarding extraction method of different products of wood.

Theory

UNIT I

Importance of forest-based industries in relation to Indian economy. Chemistry in relation to forest products

UNIT II

Description of different forest-based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of woods of lesser known forest species for commercial purposes.

UNIT III

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood - water and organic solvent soluble. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT V

Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest-based dyes and pigments.

Practical

Estimation of cell wall contents - Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood. Visit to nearby forest-based industries.

Suggested Readings

Principles of Eood Science and Technology (Solid wood) Vol. I & II by FP Kollmann and Wilfred A. Cote Jr.
Indian Forest Utilization, Vol. I FRI Dehradun Publication.
Text Book of Wood Technology by A.J. Panshin and Carlde Zeeuw.
An Introduction to Plant Anatomy by Arthur J. Eames and Lausence H. McDaniel.
Indian Forest Utilization Vol. I FRI Dehradun, Publication.
A key of Identification of Fifty Important Timbers of India, FRI, Dehradun.
Anatomy of Wood- its Diversity and Variability by Wilson K and D.J.B. White.
The chemistry of solid wood by Roger Rowell.
Principles of wood Science & Technology-I Solid Wood by Kollmann FP & Widfred A. Cote Jr.
The chemistry of Natural Products (Vol.-II): The Natural Pigments by K.W. Bentley.
The chemistry of plant gums and mucilages by F. Smith and R. Montyomery.
Wood chemistry: Fundamentals and applications by E.S. Jostrom.
Methods of wood chemistry (Vol. I and II) by B.L. Browning organic chemistry by R.T. Morisson and R.N. Boyd.

Major Courses

FBT-522 Reproductive Biology of Forest Trees 3(2+1)

Objective

To impart the knowledge of reproduction in forest tree species and to make them understand the mechanism of breeding, sex expression.

Theory

UNIT I

Reproductive biology; Importance and application of reproductive biology in tree breeding.

UNIT II

Modes of reproduction: sexual, asexual and vegetative and their breeding systems and sex expression, monoecy, dioecy and its evolution.

UNIT III

Environmental effects on sex expression. Floral biology. Initiation and development. Modes of pollination; self/out-crossing/Geitonogamy and its effect in genetic structure of forest trees. Fertilization in hardwood and softwood species. Pollen handling techniques.

UNIT IV

Seed dispersal: modes and units; modifications for wind and animal dispersal, Seed dormancy and importance in forest regeneration.

Practical

UNIT I: Sex expression in forest trees.

UNIT II: Out crossing mechanisms in forest trees.

UNIT III: Measurement of pollen flow in wind-pollinated and insect-pollinated species.

UNIT IV: Pollen viability and fertility. Seed dispersal mechanism.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.
Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.
Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer. Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.
Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.
Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding.* ICAR.
Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.
Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement.* John Wiley & Sons.
Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT-523 Quantitative Genetics in Forest Tree Breeding 3(2+1)

Objective

To impart knowledge in the field of biometry as applied to breeding, population, provenance and making experiment in forest genetics and tree breeding.

Theory

UNIT I

Historical aspects of quantitative genetics; multiple-factor-hypothesis. Population structure, mating systems.

UNIT II

Hardy-Weinberg equilibrium: properties and implications of equilibrium influence of mutation, migration and selection. Random mating; consequences in small populations. Random drift, inbreeding coefficient, rate of inbreeding.

UNIT III

In breeding in pedigreed population, inbreeding coefficient under regular systems of inbreeding. Statistical parameters used in studying polygenic traits.

UNIT IV

Testing and estimating: population mean and components of phenotypic value, breeding value, dominance, interaction and environment deviation. Models of gene action, significance of different genetic components, G x E component of variance.

UNIT V

Estimation of genetic components of variance through resemblance of relatives. Fisher's fundamental theorem on natural selection and its implications. Heritability-its estimation and significance.

UNIT VI

Selection theory for a quantitative character. Prediction of selection response: patterns, asymmetry, and causes. Selection criteria and use of information from relatives. Correlation among characters, correlation response and indirect selection.

UNIT VII

Effect of inbreeding on mean and variance. Heterosis and causes for heterosis in F1 and later generations. Combining ability effects, variances and selection for combining ability. Threshold characters.

Practical

UNIT I: Problems on multiple factors inheritance - Partitioning of variance - Estimation of heritability and genetic advance - Covariance analysis - Correlation analysis.

UNIT II: Estimation of heterosis: standard, mid-parental and better-parental heterosis - Estimation of inbreeding depression.

UNIT III: Estimation of different types of gene actions. Partitioning of phenotypic variance and co-variance into components due to genotypes, environment and genotype x environment interactions.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer. Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding.* CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding.* ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley& Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT-524 Forest Botany and Seed Technology 3(2+1)

Objective

To impart knowledge and develop understanding about tree seeds and botany aspects in forest trees.

Theory

UNIT I

Introduction to Botany; geological time scale, General classification of plants – Phanerogams, Cryptogams, Angiosperms and Gymnosperms, Dicotyledons and Monocotyledons; Basic types of tissues (Structure and Function) - Dermal, Vascular and Ground tissues; Parenchyma, Sclerenchyma, Collenchyma, Chlorenchyma, Aerenchyma, Cambium, Xylem and Phloem; Types of vascular bundles in flowering plants. Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems, limiting factors in tree propagation and afforestation.

UNIT II

General body organization and characters of Algae (e.g. Chlamydomonas), Fungi (Mucor), Bryophytes (Moss) and Pteridophytes (Nephrolepis); Parts of flowering plants- Root system and Shoot system, typical structure of root, stem and leaf; Functions of root, stem and leaves.

UNIT III

Basic Structure of Flower- Essential and Non-essential parts of flower; Morphology of root, stem and leaves; Morphology of Flower with emphasis on Inflorescence; Types of Phyllotaxy and Venation in leaves, types of placentation and aestivation in flower.

UNIT IV

Reproductive biology in seed plants - development and maturation of seed bearing organs and seeds - morphology of fruit and seed - seed dispersal - ecological fruit and seed types - seasonality and periodicity of flowering and fruiting - reproductive age - influence of external factors on seed production.

UNIT V

Seed structure and chemical composition; development and maturation; germination – breakdown of storage products – endogenous hormonal regulation – effect of stimulators and inhibitors. Dormancy – its causes and breakage specific problems of seeds of woody plants. Modes of seed dispersal.

UNIT VI

Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing. Storage methods – loss of viability during storage. Dormancy and pre-treatment. Germination and seedling establishment and seed testing techniques. Quality seed production technologies - seed certification.

UNIT VII

Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological changes during ageing. Viability and vigour. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment.

Practical

UNIT I: Morphology of root, stem and leaves with special emphasis on underground and aerial modifications in root and stem; simple and compound leaves; types of phyllotaxy and venation (live specimens)

UNIT II: Typical structure of bisexual flower; types of inflorescence (live specimens); types of tissues with the aid of permanently mounted slides;

UNIT III: Tissue organization in Dicot root, stem and leaves; Tissue organization in Monocot root, stem and leaves with the aid of permanent slides or study charts.

UNIT IV: Identification of forest seeds. Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit.

UNIT V: Tests of viability viz., cutting, hydrogen peroxide, excised embryo, tetrazolium, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests, recording, calculation and use of results of seed treatment.

Suggested Readings

Ashok Bendre and Ashok Kumar. (1984). *Textbook of Practical Botany*. Vol. I and II. Rastogi Publications. Meerut. India. (Also available on Flipkart and Amazonbooks. Com)

Ashok Bendre and P. C. Pande. (1996). *Introductory Botany*. Rastogi Publications. Meerut. India.

Ashok Kumar (2001). *Botany in Forestry and Environment*. Kumar Media (P) Ltd. Gandhinagar, Gujarat.

Baldwin, H.I. 1942. *Forest Tree Seed of the North Temperate Regions*. Periodical Experts Book Agency, Delhi.

Chin, H. F. and Roberts, E. H. 1980. *Recalcitrant crop seeds*. Tropical Press Sdn. Bhd. Malaysia.

Hong, T. D. and Ellis, R. H. 1996. *A protocol to determine seed storage behaviourIPGRI* Technical Bulletin No. 1. (J. M. M. Engels and J. Toll, vol. Eds.) International Plant Genetic Resources Institute, Rome, Italy.

Khullar, P. et. al. 1992. *Forest seed*. ICFRE, New Forest, Dehra Dun. Leadem, C.L. 1984.

FBT- 525 Breeding Methods in Forest Trees 3(2+1)

Objective

To acquaint the students about the concepts of sub- selection, population structure for breeding and production, genetic testing and making designs.

Theory

UNIT I

Genetic constitution of tree populations, half-sib, full-sib family in trees. Hardy-Weinberg equilibrium, changes in gene frequency through selection, migration, mutation and population sizes.

UNIT II

Long-term and short-term breeding populations. Selective breeding methods- mass, family, within family, family plus within family. Grading system of plus trees in natural stands and plantations regression systems, mother tree selection, and subjective evaluation. Selection for different traits.

UNIT III

Genetic testing programmes – mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating.

UNIT IV

Experimental designs in genetic testing. Selection for disease resistance, tolerance to herbicide, salt, metals, high and low temperature, water stress. Marker assisted selection.

UNIT V

Breeding methods for wood quality, agroforestry, diseases and pest resistance, drought and salt resistance.

Unit VI

Tree improvement case histories. Calculating gene and genotype frequencies. Flow chart for different breeding methods.

Practical

UNIT I: Half-sib, full-sib family in trees.

UNIT II: Grading system of plus trees in natural stands.

Unit III: Mating designs, complete designs – nested designs, factorial, single pair mating, full diallel, half diallel and partial diallel, incomplete pedigree designs – open pollinated mating and polycross mating. Selection for biotic and biotic stresses.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard Forestry*. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics.* Kluwer.Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests.* John Wiley & Sons.

FBT-526 Forest Genetic Diversity and Conservation 3(2+1)

Objective

To provide the students' knowledge about the genetic diversity in forest tree species, their distribution, assess and analysis laws and methodologies of in-situ and ex-situ conservation.

Theory

UNIT I

Biological diversity-concept, ecosystem levels. Genetic diversity and differentiation-definition, characteristics and importance for tree breeding. Genetic erosion. Techniques to assess genetic diversity. Analysis of karyotypic variation.

UNIT II

Molecular approaches for assessing genetic diversity. Inventory and monitoring biodiversity: sampling strategies for genetic diversity assessments sufficiency of sampling procedures, neutral allele model and optimal allocation of sampling efforts.

UNIT III

Effects of sampling on genetic diversity. Factors influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Global and local initiations for bio chemistry conservation.

UNIT IV

Laws and policies. Methods for maintenance of conservation: Gene banks, arboreta, gardens, breeding populations as repositories of gene conservation. Rare, endangered and endemic plants (IUCN).

UNIT V

Techniques for survey and assessment of endangered plants. Rarity patterns and endemism. Concept of island biogeography. Managing corridors and natural habitat fragments.

UNIT VI

Monitoring and recovery plans for endangered plants. Plant community reserves. Managing wild flora tourism impacts and urbanization of rare plants. Implications of rarity.

Practical

UNIT I: Estimation of productivity of forest ecosystem.

UNIT II: Collection and preservation of specimen,

UNIT III: Measurement of biomass

UNIT IV: Quantification of litter production and decomposition.

UNIT V: Visit to national parks, wildlife sanctuaries, botanical gardens and arboreta.

UNIT VI: Conservation laws and acts. Survey exploration and sampling strategies.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. Seed Orchard Forestry. Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer. Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding.* CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding*. ICAR.

Wright JW. 1976. *Introduction to Forest Genetics.* Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT-527 Forest Biotechnology 3(2+1)

Objective

To imbibe an understanding of scope, potential and techniques in forest biotechnology and to prepare them for experimentation in the discipline.

Theory

UNIT I

Principles and prospects of micro-propagation- Organogenesis, embryogenesis - Shoot tip cultures – Micro-propagation of tree species: the problems and prospects.

UNIT II

Hardening of tissue culture raised plants and green house designs. Protoplast isolation. Culture and fusion techniques, cybridization: applications. Synthetic seeds - commercial applications.

UNIT III

Genetic engineering for gene transformation - Disease elimination in trees - Microbial strain improvement by biochemical and molecular techniques - Transfer of NIF-genes from microorganisms to higher plants.

UNIT IV

Industrial important microbes – Antibiotics, enzymes, pigment producers – Bioremediation and bioleaching – Fermentation techniques. Microbial control of forest insect pests.

UNIT V

Genetic improvement of entomopathogens - Recombinant DNA technique and cloning Bt. toxin gene into other microbes - Transgenic plants with Bt. toxin gene - trypsin inhibitor gene in plants.

UNIT VI

Genetic control of insects - Genetic improvement of parasitoids and predators.

Practical

UNIT I: Preparation of media.

UNIT II: Shoot tip culture, callus initiation. Organogenesis - embryogenesis in tree species

UNIT III: Protoplast isolation, culture, fusion and plant regeneration.

UNIT IV: Testing the efficiency of microbial mutants.

UNIT V: Rhizobium, phosphate solubilizers and cellulose and lignin degrading microorganisms.

UNIT VI: Study of entomopathogen of forest insects – Mass production of Bt.

Suggested Readings

Joshi Rajmohan,. *Agricultural Biotechnology*., 2006, Isha Books, New Delhi (India).

Keshavachandran, 2008, *Plant Biotechnology, Methods in Tissue Culture and Gene Transfer*, Universities Press, Hyderabad (India).

Khan Irfan Ali. and Khanum Atiya., 2008, *Role of Biotechnology in Medicinal and Aromatic Plants,* Volume I – XX Ukaaz Publishers, Hyderabad (India).

Naidu, C. K., *Applied Biotechnology*., 2005, Pointer Publishers, Jaipur (India).

Scragg, A. H. and Scragg Alan., 2005, *Environmental Biotechnology,* Oxford University Press.

Singh, B. D., 2008, *Biotechnology,* Kalyani Publishers, New Delhi (India).

Slater Adrian, Scott Nigel. and Fowler Mark., 2007, *Plant Biotechnology*. Oxford University Press.

Sudhir, M., 2005, *Forest Biotechnology*. Dominant Publishers and Distributors.

FBT-521 Tree Seed Orchards 3(2+1)

Objective

To develop understanding of students about tree seed orchards.

Theory

UNIT I

Importance of genetically improved seed in plantation forestry. Status of seed production among major plantation species. Short term supply of superior seed.

UNIT II

Selection and delineation of seed stands, seed production areas, seed zones, seed ecological zones.

UNIT III

Seed orchard: need, evolving seed orchards. Containerized seed, hybrid and research seed orchards; first, second and advanced generation seed. Seed orchard genetics: random mating, gamete exchange and parental balance. Estimation of genetic parameters from seed orchard data. Ortet age and its effect on seed production.

UNIT IV

Importance of progeny testing. Establishment of seed orchards, selection and preparation of orchard site, isolation, orchard size, and designs. Seed orchard management: rouging, silvicultural practices to increase seed yield.

UNIT V

Pest and disease management. Seed collection and record keeping, seed orchard registration and documentation. Importance of seed orchards in gene conservation.

Practical

UNIT I: Visits and study of seed orchard designs.

UNIT II: Estimation of overlap in flowering among genotypes.

UNIT III: Study of inter and intra-clonal variation in floral, seed characters. Effect of girdling on flowering.

UNIT IV: Plant growth regulator application for flower induction.

UNIT V: Pollen viability/fertility. Assessment of pollen dispersal. Supplemental mass-pollination.

UNIT VI: Effects of foliar application of fertilizers on seed set.

UNIT VII: Estimation of genetic parameters for a few traits. Estimation of parental balance.

Suggested Readings

FAO. 1985. *Forest Tree Improvement*, FAO Publi.

Faulkner R. 1975. *Seed Orchard Forestry.* Commission Bull. No.34.

Fins L, Friedman ST & Brotschol JV. 1992. *Handbook of Quantitative Forest Genetics*. Kluwer.Khosla PK. 1981. *Advances in Forest Genetics*. Ambika Publ., New Delhi.

Mandal AK & Gibson GL. (Eds.). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN & Parmathama M. (Eds.). 2003. *A Text Book of Forest Tree Breeding.* ICAR.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

Zobel BJ & Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley & Sons.

Zobel BJ, Wyk GV & Stahl P. 1987. *Growing Exotic Forests*. John Wiley & Sons.

FBT- 531 Clonal Forestry 3(2+1)

Objective

To develop understanding of students about clonal propagation techniques in forestry.

Theory

UNIT I

Clonal approaches in tropical forestry, Advantages of clonal forestry, Different cloning techniques, Strategy for clonal forestry,

UNIT II

Clonal forestry for enhanced pulpwood productivity, Clonal forestry as Natural progression in tree improvement, Clonal forestry concerns and changes in forestry practices due to clonal forestry,

UNIT III

Bulk Propagation versus Clonal Forestry, Clonal forestry: as a need for continued improvement. Selection of plus trees for cloning in wild fruit trees,

UNIT IV

Identification of plus trees for cloning of pulp wood species, Criteria for evaluation of clones of pulp wood.

UNIT V

Grafting techniques for cloning of important forest tree species, Clonal nursery techniques for important pulp wood species,

UNIT VI

Diseases and their management of eucalypts and acacias important pulp wood species in clonal forestry, Pests and their management of eucalypts and acacias important pulp wood species in clonal forestry,

UNIT VII

Silvicultural management for higher productivity of pulp wood plantation, Future of clonal forestry.

Practical

UNIT I Study of inter and intra-clonal variation in floral, seed characters.

UNIT II Selection and identification of plus trees

UNIT III cloning of important forest tree species: Teak (*Tectona grandis*), Tamarind (*Tamarindus indica*), Ber (*Zizyphus jujuba*), Kokum (*Garcinia indica*), Wood Apple (*Feronia elephantum*), Honge or Karnaj (*Pongamia pinnata*) by grafting techniques .

UNIT IV The technique of establishment and management of CMA of Eucalyptus and acacias or Casuarina**.**

Suggested Readings

Ahuja, M.R. and Libby, W.J. 1993. *Clonal Forestry 1: Genetics and Biotechnology*.

Springer-Verlag, Berlin, 240 p.

Evans, J. and Turnbull, J.W. 2004. *Plantation Forestry in the Tropics*. 3 editions.

Oxford University Press, UK.

Foster, G.S. and Bertolucci, F.L.G. 1994. *Clonal development and deployment strategies to enhance gain while minimizing risk. In: Tropical Trees: The Potential for Domestication and the Rebuilding of Forest Resources.* (Eds.) R.R.B. Leakey and A.C. Newton, HMSO, London, pp 103-111.

Libby, W.J. 1982. *What is a safe number of clones per plantation? In: Resistance to Diseases and Pests. (*Eds.) H.M. Heybroek, B.R. Stephan and K. von Weissenberg, Pudoc. Wageningen, The Netherlands, pp 342-360.

Minor Courses

STAT-512 Statistical Methods and Computer Application 3(2+1)

Objective

To impart basic knowledge in the student about statistical methods and application of computers in their research field.

Theory

UNIT I

Need for statistics in forestry experimentation and planning – population and sample. Correlation and regression: correlation coefficient/coefficient of determination, simple regression analysis; examples of multiple regressions. Examples of linear regression and its fitting by least square method.

UNIT II

Normal distribution and its application in forestry - properties of normal distribution. Confidence limits. Expected value of mean and standard error.

UNIT III

Tests of significance - Test for means in one sample and two sample cases (Z and t tests). Z-test for proportion, Chi-square test of variance in one sample case.

UNIT IV

F-test of variance in two sample cases. Test of equality of K - means (one way and two way classification). Probability, basic laws of probability.

UNIT V

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.

UNIT VI

Need for sampling in forestry. Complete enumeration Vs partial enumeration. Principal steps in sample surveys, population, sampling unit, size of sample, (sample intensity) bias, accuracy and precision. Sampling variation and estimation of sampling error. Determination of sample *size* for a given level.

UNIT VII

Classified sampling design used in forest surveys. Simple random sampling - stratified random sampling. Systematic sampling - Point sampling.

UNIT VIII

Basic principles of design of experiments, Uniformity trials and their uses, Fair field Smiths Variance Law and optimum size and shape of plots. Design and analysis of C.*R.D.* R.B.D. and L.S.D. with one observation per cell.

UNIT IX

Factorial experiments: Symmetrical and Asymmetrical factorial experiments, 2^n factorial experiments, Yates method and general method of analysis of AxB and AxBxC factorial experiments.

UNIT X

Layout and analysis of Split and Strip plot design. Missing plot technique in R.B.D. and L.S.D. with one observation missing.

UNIT X1

Transformations: Square root, Logarithmic and Angular transformation.

UNIT XII

Introduction to computer, MS Office, Statistical Application packages like MS-Excel, SPSS, R-software.

Practical

Laying out of designs in the field. Analysis of 2^2 and 2^3 experiments in R.B.D., Analysis of AxB factorial experiments. Analysis of AxBxC factorial 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. Analysis of results of the above design, Application of Statistical Packages like MS-Excel, SPSS, R-software with real forestry data.

Suggested Readings

V.G. Panse and P.V. Sukhatme (1985). *Statistical Methods for Agricultural Workers.* ICAR, New Delhi.

S.C. Gupta and V.K. Kapoor (2014). *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons, New Delhi.

Sukthame and C. Ashok (1984). *Sampling Theories and Surveys with Application*. ICAR, New Delhi, 3rd ed.

G.N. Rao (1983). *Statistics for Agricultural Science*. Oxford and IBH, New Delhi.

Das, M.N. and Giri. N.C. (1986). *Design and analysis of Experiments. New Age* International Publishers.

Kingra, H. S., Singh, G. (1993). *Computer Basics for forestry*, International Book Distributors, Dehradun.

Rajaraman, V and Adabala, N. (2015). *Fundamentals of Computers,* Pearson Education, New Delhi.

FBT- 532 Forest Ecology and Biodiversity Conservation 3(2+1)

Objective

To develop understanding of students about ecological aspects of forest, conservation of forest resources & biodiversity, consequences of depleting biodiversity and sustainable use of biodiversity.

Theory

UNIT I

Forest ecology; forest population, forest community dynamics, forest community structure and analysis, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology.

UNIT II

Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve). Global warming and forests. Green House Effect and its consequences. Ozone depletion; impact and control measures. environmental monitoring; concept of sustainable development. Role of trees and forests in environmental conservation; control and prevention of air, water and noise pollution. Environmental policy and legislation in India.

Unit III

Forest genetics resources of India: major timber and non-timber species. Survey exploration and sampling strategies.

UNIT IV

Documentation and evaluation of forest genetic resources (FGR), in situ and ex situ conservation of gene resources. Biological diversity and its significance to sustainable use.

UNIT V

Handling and storage of FGR. Intellectual property rights. Quarantine laws and FGR exchange.

Practical

UNIT I: Study of forest community structure and its successional status

UNIT II: Estimation of productivity of forest ecosystem

UNIT III: Trip to different regions of the state to study forest vegetation, Collection and preservation of specimen.

UNIT IV: Methods of vegetation analysis.

UNIT V: Measurement of biomass and productivity

UNIT VI: Visit to national parks, wild life sanctuaries, botanical gardens and arboreta.

Suggested Readings

Anonymous 2006. *Report of the National Forest Commission*. Govt. of India.

Dhyani SN. 1994. *Wildlife Management.* Rawat Publ.

Huxley P. 1999. *Tropical Agroforestry*. Blackwell.

Khan TI & Al-Azmi DN. 1999. *Global Biodiversity Conservation Measures.* Pointer Publ.

Kimmins JP. 1976. *Forest Ecology*. MacMillan.

Nautiyal S & KoulAK. 1999. *Forest Biodiversity and its Conservation Practices in India*. Oriental Enterprise.

Ramakrishnan PS. 1992. *Shifting Agriculture and Sustainable Development*. Man, and Biosphere Series. The Parthenon Publ. Group.

NRM- 511 Forest Soils and Land Reclamation 3(2+1)

Objective

To develop understanding and management skills of the students for forest soils and land reclamation practices

Theory

UNIT I

Introduction; Forest soil and its classification, soil forest types, Forest soils vs. cultivated soils. Genesis of forest soils, Properties of soils under different forest ecosystems.

UNIT II

Soil and tree planting, Amelioration of forest soils. Characterization of wasteland, present status and extent of non-arable lands and their productivity.

UNIT III

Salt affected soils, lateritic, marsh and swampy and rocky hills, rocky plains, murrammy and sandy soils, their characteristics and reclamation.

UNIT IV

Sites with superficial impervious hard pan. eroded ravines and gullies, various techniques of afforestation of adverse sites, trees suitable for adverse sites.

UNIT V

Afforestation and reclamation of mine wastes. Stabilization of tailing dumps and prevention of dust pollution. Sewage water as source of tree nutrients.

Practical

Exercise on sampling methods; Exercises on land use classes; Exercises on light-spectral characteristics; Analysis of soil for Gypsum and lime requirement; Exercises on study of eroded soils; Study on types of pits and trenches, tree species suitable for mined out areas; Visit to nearest mined areas. Drainage and reclamation of water logged lands; Measurement of irrigation water by various method; Design of graded bunds; Design and layout of waterways; Survey design and layout of bench terraces; Design and layout of diversion channels; Study of different water harvesting structures; Land leveling and its cost estimation; Study of drip irrigation system; Study of sprinkler irrigation system; Study of pumping system; Economic analysis of wasteland development.

Suggested Readings

R.K.Luna 1996 *Plantation Forestry*
Wilde, S.A. 1994 *Forest soil and Forest growth*
Dewedi, A.P. 2002 *A Textbook of Silviculture*

SAF – 511 Forests and Climate Change 3(2+1)

Objective

Importance of forests and vegetation in the present era of climate change.

Theory

UNIT I

Weather and Climate, Climatic zones of India. Evaporation and transpirationcomponents of atmosphere, hydrosphere, pedosphere, biosphere and their interactions. Ecosystems of the world, Climate and its impact on agriculture, agro-climatic regions, soils and cropping patterns of India and agriculture productivity.

UNIT II

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest

UNIT III

Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on forests and agro-forestry- Climate resilient forestry.

UNIT IV

Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change.

UNIT V

National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere. Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer.

Suggested Readings

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and ForestGenetic Diversity: Implications for Sustainable Forest Managementin Europe*. Biodiversity International, Rome, Italy.

Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur

NRM – 531 Remote sensing and Geographic Information System 3(2+1)

Objective

Importance Remote sensing, components of Digital image processing, image analysis and classification, Use of GIS and GPS. Use of GIS software in Forestry.

Theory

UNIT I

Orientation to subject- use History and use of aerial photography, Satellite imagery and geographic information system

UNIT II

GIS for the collection, storage and spatial analysis for geo-referenced forest resources data and information.

UNIT III

The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management

UNIT IV

Satellite systems; satellite imageries – techniques, uses and limitation, Future prospects of remote sensing in India

UNIT V

Software used in remote sensing; GIS versus remote sensing; GIS Software used in forestry and environments, Analysis of data; Application of GIS in forestry.

Practical

Uses of various photogrammetry instruments, Recognition and identification of objects on photography, Compilation of maps and their interpretation, Hands on practice on remote sensing software, Hands on practice on GIS software

Suggested Readings

Burrough P.A.1990. *Principles of GIS for Land Resources Assessment*. Oxford and IBH.
Lillsand T. M.1989. *Remote Sensing and Image Interpretation*. John Wiley.
Narayanan L.R.A. 1999. *Remote Sensing and its application*. University Press(India)/Orient Longman.
Sharma, N. K. 1986. *Remote Sensing and Forest Survey*. IBD, Dehradun.

NRM- 512 Land use and Watershed Management 3(2+1)

Objective

To impart knowledge to students regarding Watershed characteristics, Components of natural resources for watershed management, People participation in watershed management

Theory

UNIT I

Soil and Land, Land use patterns in India and Rajasthan, Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency. Biota- vegetation types, distribution and utilization.

UNIT II

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity issues. Formulation of watershed projects (micro and macro watershed).

UNIT III

Components of natural resources for watershed management. Preparation techniques for micro plan of watershed. Impact assessment techniques for upliftment of socio-economic status and environment. Valuing Inputs and Outputs.

UNIT IV

Watershed survey, mapping and structural engineering designs-Compass, Surveying, Plane table surveying, Leveling, Preparation of contour maps of watershed. Terraces and bunds- types & design.

UNIT V

Soil and water conservation and water harvesting structures – types & design. Sedimentation- sources, estimation of sediment bank treatment techniques. Hydrological cycle and characteristics of small and medium watersheds precipitation, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water and evapo-transpiration. Resources inventory soil, land, water and Biota.

UNIT VI

People participation and impact analysis in watershed management- Community organizations – Definition, Principles advantages, Community mobilization. Psychodynamics of group processes decision making, leadership, and conflict management and group strategies. Participatory planning, implementation, monitoring and evaluation. Participatory research approaches. Socio economic impact analysis, financial analysis.

Practical

Survey of watershed, Preparation of micro-plan and planning of watershed for effective implementation. Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Study of flood control reservoirs; Exercises on economic profitability of various land-based enterprises bases in cost and revenue concepts. Preparation of contour maps, Estimation of earth work, Design of check dams, Acquaintance with water lifting devices, Use of measurement, Conveyance and control structures.

Suggested Readings

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.
Murty, J.V.S. 1995. *Watershed Management in India*. Wiley Eastern, New Delhi.
Oswal MC. 1999. *Watershed Management (For Dryland Agriculture),*Associated Pubg Co., Delhi.
Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.
5.Dhuruva Narayana, V.V., Sastry, G. and Patnaik, V.S. 1990. *Watershed Management*. ICAR Publication, New Delhi.

SAF- 512 Ecotourism and Participatory Forestry 3(2+1)

Objective

To impart knowledge to students regarding ecotourism in Indian context and its role for sustainable development of PA's.

Theory

UNIT I

Eco tourism - study history of tourism- identify various forms of tourism and evolution of ecotourism. Mass tourism versus ecotourism. Organized tours and Free Independent Travelers.

UNIT II

World Tourism Organization. Problems with definition of ecotourism and criticisms. Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Different forms of ecotourism like hard and soft ecotourism.

UNIT III

Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism. Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context. Planning ecotourism in protected areas. - Visitor management in ecotourism areas - zoning, carrying capacity.

UNIT IV

Participation of local people in ecotourism., PRA and RRA, Ecotourism for sustainable development of PA's. New directions in ecotourism industry. Ecotourism in practice in important PA's of India - case studies Limitations and problems of ecotourism.

UNIT V

Ecotourism as a way for sustainable management of natural resources. Local livelihoods and eco-tourism like nomadic grazing, agro- pasturatism). Desiging and landscaping in ecotourism. Design and management of ecotourism. Economics of ecotourism. Modern Research approaches on Eco-tourism.

Practical

Students should make detailed reference on the various forms of Ecotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism. Problems on common property resources and facilitate group discussion for recommendations. Evaluation and monitoring of the various ecotourism activities of the region such as Nature Walk - The guided day trek, The Tiger Trail, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage, Jungle Inn, The Sacred groves, Bamboo Grove, Green Mansions, the backwater cruise. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area, evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

SAF-537 Forests and People 3(2+1)

Objective

To acquaint the students about interactions between forests and people; significance of forests in livelihood of tribal and other people; also, to deal with some common issues related to forests.

Theory

Forests and its importance, forest societies, interactions between forests and people, importance of forests in traditional farming systems, livestock economy and forests, social and cultural factors of forest management, man in ecosystem in relation to eco-philosophy. Afforestation programmes and forest conflicts, wildlife and human conflicts, important forest movements like Chipko Movement, Gender dimension of forest management, tribal economy and forests. Pastoralists and their dependence on forests. Tribology: Forests and economic security of tribals. Management of Commons and Common Property Resources (CPRs) and open access resources, forest management and sustainable livelihood strategies, forests and food security, eco-tourism and local development, land use change and forestry. Forest rights, customary rights of people, community participation, biodiversity and ethnobotany, Joint Forest Management, global environmental change and land use; dams, forests and resettlement of tribals and non-tribals – case study, poverty alleviation and forests, tourism and forest management, role of NGOs and other CBOs community-based organization in forest management.

Practical

Study of tribal areas. Camping in forests and assessment of biodiversity rich areas. Flora and fauna inventorization. Socio-economic survey of the Tribal areas. Study of sacred groves in Rajasthan. Camping in forests (Wildlife sanctuary and National park) will be made for 5 days to study the above topics.

Suggested Readings

Shah, S.A. 1988. *Forestry for People*. ICAR Publications.
Maheshwari, K. 1998. *Ethnobotany in South Asia*. Scientific Publishers.
Gupta, H.K. 2006. *Joint Forest Management Policy Participation and Practices in India*.International Book Distributors, Dehradun.

Non-credit Courses

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

Objective

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

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, 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 article.
Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins, London
Gordon HM and Walter JA. 1970. *Technical Writing.* 3rd Ed. Holt, Rinehart and Winston.
Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English.* 6th Ed. Oxford University Press, Oxford
James HS. 1994. *Handbook for Technical Writing.* NTC Business Books.
Joseph G. 2000. *MLA Handbook for Writers of Research Papers.* 5th Ed. Affiliated East-West Press.
Mohan K. 2005. *Speaking English Effectively.* MacMillan India.
Richard WS. 1969. *Technical Writing.* Barnes & Noble.
Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language.* Abhishek. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English.* 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. *High School English Grammar and Composition.* S. Chand & Co. New Delhi.

PGS- 503 Intellectual Properties And Its Management In Agriculture (1+0)

Objective

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

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology.* CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy.* McGraw-Hill, New Delhi.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

Ministry of Agriculture, Government of !ndia. 2004. *State of Indian Farmer.* Vol. V. *Technology Generation and IPR Issues.* Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics.* CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies.* Daya Publ. House, New Delhi.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS- 506 Disaster Management (1+0)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Gupta HK. 2003. *Disaster Management.* Indian National Science Academy. Orient Blackswan.

Hodgkinson PE and Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management.* Routledge, London.

Sharma VK. 2001. *Disaster Management.* National Centre for Disaster Management, India.

Non -credit Deficiency Courses

(Required to be offered by the students not having B.Sc. Forestry degree programme)

FORT -451 Practices of Silviculture 3(2+1)

Objective

To acquaint the students about general practices of silviculture in India and Rajasthan with examples of important trees.

Theory

UNIT I

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT II

Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration.

UNIT III

Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

UNIT IV

Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration- accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

UNIT V

Tree planting- Sowing v/s planting different kinds of pits. Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

UNIT VI

Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations, -objectives and uses

Practical

Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices.* Oxford and IBH, New Delhi.

Khanna LS. 1996. *Principle and Practice of Silviculture.* International Book Distributors, Dehradun.

Dwivedi AP. 1993. *A Text Book of Silviculture.* International Book Distributors, Dehradun

Khanna L. 1996. *Principles and Practices of Silviculture.* International Book Distributors, Dehradun

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-applied Forest Ecology.* John Wiley and Sons, New York.

FORT -452 Forest Products and Utilization 3(2+1)

Objective

To acquaint the students about various forest products, availability of raw material and best utilization practices in India.

Theory

UNIT I

Introduction, methods of collection, management and importance of Non-Wood Forest Products (NWFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non-Essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees.

UNIT II

Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits and vegetables, spices, poisons and bio-pesticides. Honey, Lac, and silk- their importance, extent and processing.

UNIT III

Pulp and paper industry. Introduction and raw material; pulping mechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT IV

Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board.

UNIT V

Adhesives used in manufacture of composite wood. Improved wood, definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood. Production of wood molasses, alcohol and yeast.

Practical

Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood-based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR Publ., New Delhi.
Anonymous. 2007. *Year Book of Forest Products*. FAO.
Dwivedi AP. 1993. *Forestry in India*. Surya Publ., New Delhi.

FORT -453 Dendrology and Forest Botany 3 (2+1)

Objective

To acquaint the students about various forest plants and trees, their identification and systematic.

Theory

UNIT I

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature.

UNIT II

Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc.

UNIT III

Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts.

UNIT IV

Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system.

UNIT V

Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Santalaceae, Papilionaceae, Caesalpiniaceae Mimosaceae, Elaeagnaceae, Meliaceae, Salicaceae, Rutaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Asteraceae, Moraceae, Poaceae, Tiliaceae, Euphorbiaceae, Myrtaceae and Combretaceae, Liliaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae,.

UNIT VI

Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. Study of woody flora of: Magnoliaceae, Ebenaceae and Tiliaceae; Papilionaceae, Caesalpiniaceae and Mimosaceae;; Moraceae and Poaceae; Meliaceae, and Salicaceae; Apocynaceae; Combretaceae, Myrtaceae and Santaleceae; Asteraceae, Sapotaceae and Verbenaceae; Euphorbiaceae and Liliaceae.

Suggested Readings

Bhandari, M.M. (1978). *Flora of Indian Desert*, Scientific Pub., Jhodhpur, Pp. 471.

Bor, N.L. (1996) *Manual of Indian Forest Botany*, IBD Pub., Dehradun, Pp. 441.

Brandis, D. (1874). *The Forest Flora of North-west and Central India* (Repr. Ed. 1972). Bishen Singh & Mahendra Pal Singh, Dehradun, India.

Chauhan, P.S. (2006). *Biodiversity Assessment Survey of Hadoti Region, Rajasthan-PartII: Floral Diversity of Jhalawar and Kota Districts,* Technical report submitted to College of Horticulture and Forestry, Rajathan, Pp. 27+Appendix-1+III Plates.

Chauhan, P.S., Manmohan, J.R., Prahlad, V.C. and Pandey S.B.S. (2006). *Practical Manual on Dendrology for B. Sc. (Forestry); submitted to College of Horticulture and Forestry,* MPUAT. Rajasthan, Pp. 44.

Dasgupta, S. (1988). *Systematic Botany for Foresters,* Khanna Bandhu Pub., Dehradun, Pp. 210.

Datta, S. C. (1988). *Systematic Botany*, New Age International pub., Pp. 653

Harlow, William M., Editor (1995). *Textbook of Dendrology*, Authors, Ellwood S. Harrar, James W. Hardin, Fred M. White), McGraw-Hill Companies, Pp. 534.

Krishen, Pradeep (2006). *Trees of Delhi-A Field Guide,* DK Pub., India, Pvt. Ltd. New Delhi, Pp.360.

Kumar, Ashok (2001). *Botany in Forestry and Environment*, Kumar Media Pvt. Ltd., Dehradun, Pp. 716.

Naik V. N. (2003). *Taxonomy of Angiosperms*,

Pandey, B.P. (1978). *Economic Botany,* S Chand Pub., Pp.534.

Sharma, N. (2002). *The Flora of Rajasthan*, Avishkar Pub Distributors, Jaipur, Pp.208.

Singh, V. and D.K. Jain (2006). *Taxonomy of angiosperms,* Rastogi publications.

SYLLABUS

For

M.Sc. Forestry (Silviculture and Agroforestry)

2018-19

FACULTY OF FORESTRY

DEPARTMENT OF SILVICULTURE AND AGROFORESTRY

COLLEGE OF HORTICULTURE AND FORESTRY,

JHALARAPATAN, JHALAWAR

(AGRICULTURE UNIVERSITY, KOTA)

M.Sc. Forestry (Silviculture and Agroforestry)
Semester-wise Distribution of Courses

Semester I

Course Code	Course Title	Credit Hours
FORT-511	**Silviculture and Forest Biometry**	3 (2+1)
FORT-512	**Forest Management and Protection**	3 (2+1)
FORT-513	**Tree Physiology and Tree Improvement**	3 (2+1)
STAT- 512	Statistical Methods and Computer Application	3 (2+1)
*NRM-511	Forest Soil and Land Reclamation	3 (2+1)
*NRM-512	Land use and Watershed Management	3 (2+1)
*SAF-511	Forests and Climate Change	3 (2+1)
*SAF-512	Ecotourism and Participatory Forestry	3 (2+1)
FORT-451 (Deficiency course)	Practices of Silviculture	2+1 (NC)
****Any one course to be opted out of four***		
	Total Credit Hours of Courses	**15 (10+5)**

Semester II

Course Code	Course Title	Credit Hours
*SAF- 521	Modern Nursery Technology	3 (2+1)
*SAF- 522	Plantation Forestry	3 (2+1)
*SAF- 523	Energy Plantations and Bio-fuels	3 (2+1)
*SAF- 524	Seed Collection, Storage and Testing	3 (2+1)
*SAF- 526	Soil and Water Management in Agroforestry	3 (2+1)
*SAF- 527	Agroforestry Systems	3 (2+1)
*SAF- 528	Economics of Agroforestry Systems	3 (2+1)
*SAF- 529	Fruit Plants, Trees and Shrubs for Agroforestry	3 (2+1)
PGS 502	e-course -Technical Writing and Communication Skills	0+1 (NC)
FORT-452 (Deficiency course)	Forest Products and Utilization	2+1 (NC)
Any four courses to be opted out of eight** ***(SAF- 521, 522, 523 & 524 for students intending super specialization in Silviculture and SAF- 526, 527, 528 & 529 for students intending super specialization in Agroforestry)		
	Total Credit Hours of Courses	**12 (8+4)**

Semester-III

Course Code	Course Title	Credit Hours
FORT-531	**Forest Products – Chemistry and Industries**	3 (2+1)
*SAF- 531	Nutrient and Weed Management in Nursery and Plantation	3 (2+1)
*SAF- 532	Management of Insect Pest and Diseases in Forestry	3 (2+1)
*SAF- 534	Crops and Animal Production Management in Agroforestry	3 (2+1)
*SAF- 535	Rangeland and Pasture Management	3 (2+1)
**NRM-531	Remote Sensing and Geographic Information System	3 (2+1)
**SAF-533	Forest Policy, Law and International Conventions	3 (2+1)
**SAF-536	Production Management in Nursery and Plantation Forestry	3 (2+1)
PGS 503	e-course -Intellectual Property and its Management in Agriculture	1+0 (NC)
PGS -506	e-course -Disaster Management	1+0 (NC)
FORT-453 (Deficiency course)	Dendrology and Forest Botany	2+1 (NC)
SAF-591	Credit Seminar	1 (0+1)
**** Any one course to be opted from (SAF-531 & 532 for students intending super specialization in Silviculture and from SAF-534 &535 for students intending super specialization in Agroforestry)*** *****Any one course to be opted out of three***		
	Total Credit Hours of Courses	**10 (6+4)**

Semester-IV

Course Code	Course Title	Credit Hours
SAF-541	Comprehensive (NC)	1+0 (NC)
SAF-599	Research	20 (0+20)
	Total Credit Hours (I+II+III+IV) (14+11+12+20)	**57**

MASTER OF SCIENCE IN FORESTRY **(Silviculture and Agroforestry)**

COURSES APPROVED BY THE **10th Academic council** Meeting Held on **08th June '2018** as per Agenda item No. **AUK/AC-10/2018-01/11**

CORE COURSES	FORT - 511	Silviculture and Forest Biometry	3 (2+1)
	FORT - 512	Forest Management and Protection	3 (2+1)
	FORT - 513	Tree Physiology and Tree Improvement	3 (2+1)
	FORT - 531	Forest Products –Chemistry and Industries	3 (2+1)
		Total (Core Courses)	**12(8+4)**
* * MAJOR COURSES	SAF - 521	Modern Nursery Technology	3 (2+1)
	SAF - 522	Plantation Forestry	3 (2+1)
	SAF - 523	Energy Plantations and Bio-fuels	3 (2+1)
	SAF - 524	Seed Collection, Storage and Testing	3 (2+1)
	SAF - 531	Nutrient and Weed Management in Nursery and Plantation	3 (2+1)
	SAF - 526	Soil and Water Management in Agroforestry	3 (2+1)
	SAF - 527	Agroforestry Systems	3 (2+1)
	SAF - 528	Economics of Agroforestry Systems	3 (2+1)
	SAF - 529	Fruit Plants, Trees and Shrubs for Agroforestry	3 (2+1)
	SAF - 532	Management of Insect Pest and Diseases in Forestry	3 (2+1)
	SAF - 534	Crops and Animal Production Management in Agroforestry	3 (2+1)
	SAF - 535	Rangeland and Pasture Management	3 (2+1)
** *Any five courses to be opted* (as per semester distribution option)		**Total (Major Courses)**	**15 (10+5)**
MINOR COURSES	STAT-512	Statistical Methods and Computer Application	3 (2+1)
	*NRM-511	Forest Soil and Land Reclamation	3 (2+1)
	*NRM-512	Land Use and Watershed Management	3 (2+1)
	*NRM-531	Remote Sensing and Geographic Information System	3 (2+1)
	*SAF-511	Forests and Climate Change	3 (2+1)
	*SAF-533	Forest Policy, Law and International Conventions	3 (2+1)
	*SAF-512	Ecotourism and Participatory Forestry	3 (2+1)
	*SAF-536	Production Management in Nursery and Plantation Forestry	3 (2+1)
		**Any two courses to be opted*	
		Total (Minor Courses)	**9 (6+3)**
NON - CREDIT	PGS 502	Technical Writing and Communication Skills	0+1 (NC)
	PGS 503	e-course –Intellectual Property and its Management in Agriculture	1+0 (NC)
	PGS 506	e-course- Disaster Management	1+0 (NC)
***NON - CREDIT DEFICIENCY COURSES	FORT-451	Practices of Silviculture	3 (2+1)
	FORT-452	Forest Products and Utilization	3 (2+1)
	FORT-453	Dendrology and Forest Botany	3 (2+1)
	***Required to be offered by the students not having B.Sc. Forestry Degree Programme		
	SAF-591	Credit Seminar	1 (0+1)
	SAF-541	Comprehensive (NC)	1+0 (NC)
	SAF-599	*Research*	**20 (0+20)**
		Grand Total	57

CORE COURSES:

FORT-511: Silviculture and Forest Biometry 3 (2+1)

Objective

To provide knowledge about Forest ecosystem concept, stand dynamics-forest succession, productivity and vegetation forms and natural regeneration of tree species. To develop understanding of students about tree measurements, forest inventory and yield concepts

Theory

UNIT I

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

UNIT II

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT III

Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments.

UNIT IV

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands,. Preparation of volume & its application, yield and stand tables.

UNIT V

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT VI

Growth and yield prediction models – their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practice*s. Oxford and IBH, New Delhi.

Dwivedi AP. 1993. *A Text Book of Silvicultur*e. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silvicultur*e. Khanna Bandhu, Dehradun.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons, US.

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuratio*n. International Book Distributor.

Ram Parkash 1983. *Forest Surveyin*g. International Book Distr., Dehradun.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestr*y. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuratio*n. Bishen Singh Mahender Pal Singh, Dehradun

FORT-512: Forest Management and Protection 3 (2+1)

Objective

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density and forest valuation. To provide knowledge to students about forest protection through diseases and pest management.

Theory

UNIT I

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT II

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies. Forest valuation and appraisal in regulated forests.

UNIT III

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management.

UNIT IV

Biodegradation of wood – microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots – factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health.

UNIT V

Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

UNIT VI

Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance trees.

Practical

Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Collection, identification and preservation of important insect pests and disease specimens of forest plants. Assessment of losses due to diseases, insect pests etc. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in nurseries and plantations, Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection.

Suggested Readings

Ajay S Rawat. 1991. *History of Forest in India.* Indus Pub. Co. New Delhi.

Avery and Burkhart. 2015. *Forest Measurement.* Waveland Press, Illinois.

Brasnet, NV.1953. *Planned Management of Forests*. George Allen & Unwin, London

Lawrance S. Davis and K.Morman Johson. 1987. *Forest Management*. McGraw-Hill the University of Michigan.

Maslekar.2008. *Management of Forests in India: New Opportunities*. Bishen Singh Mahendra Pal Singh, Dehradun.

Myth D Realty by J B Lal. *India's Forests*

Oliver, CD and Larson BC. 1996. *Forest Stand Dynamics*. John Wiley and Sons, New York.

Osmaston. 1968.*Management of Forest.* Hafner Pub. Co. New York.

Ram Parkash.1986. *Forest Management,* International Book Distributors, Dehradun.

Sharma, LC. *Forest Economics, Planning and Management*

Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.

Jha LK and Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House, New Delhi.

Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall, the University of Michigan.

Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.Bhopal.

FORT-513: Tree Physiology and Tree Improvement 3 (2+1)

Objective:

To acquaint the students about general principles tree physiology tree breeding with examples of important trees.

Theory

UNIT I

Introduction to tree physiology. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency..

UNIT II

Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Water relations of forest trees – Transpiration from forest canopies - Water use efficiency of forest stands. GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S. General concept of forest tree breeding, tree improvement and forest genetics.

UNIT III

Reproduction in forest trees, dimorphism pollination mechanism. Pollen dispersal, pollinators. Attractants for pollinators.

UNIT IV

Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races. Seed, seed formation, dispersal, storage and seed dormancy.

UNIT V

Selective breeding methods- mass, family, within family, plus within family. Plus tree selection for wood quality. Progeny and clone testing. Seed orchards – type, functions and importance. Estimating genetic parameters and genetic gain.

UNIT VI

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, Neem etc.

UNIT VII

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Biotechnology in tree improvement.

Practical

Estimation of stomatal index.Estimation of water potential in plants using Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, and LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc.Measurement of relative water content, leaf water potential, osmotic potential Observation on tree architecture of important species. Study of Floral biology of important trees in the region. Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones.. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids.

Suggested Readings

Hopkins, W.G. and Huner, N.P.A. (2008) Introduction to plant physiology. Wiley.

Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York

Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London

Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Managment. Academic Press Inc., London.

Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd. Singapore.

Mandal AK and Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN and Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

White TL, Adams WT and Neale DB. 2007. *Forest Genetics*. CABI, UK.

Zobel BJ and Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley and Sons.

FORT-531: Forest Products – Chemistry and Industries 3 (2+1)

Objective

The course will equip the students regarding wood based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this wood extracts resins and gums, katha, tannins and various types of non timber products. Practical will make them aware regarding extraction method of different products of wood.

Theory

UNIT I

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products

UNIT II

Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of woods of lesser known forest species for commercial purposes.

UNIT III

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood - water and organic solvent soluble. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT V

Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

Practical

Estimation of cell wall contents - Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood. Visit to nearby forest based industries.

Suggested Readings

Principles of Eood Science and Technology (Solid wood) Vol. I & II by FP Kollmann and Wilfred A. Cote Jr.

Indian Forest Utilization, Vol. I FRI Dehradun Publication.

Text Book of Wood Technology by A.J. Panshin and Carlde Zeeuw.

An Introduction to Plant Anatomy by Arthur J. Eames and Lausence H. McDaniel.

Indian Forest Utilization Vol. I FRI Dehradun, Publication.

A key of Identification of Fifty Important Timbers of India, FRI, Dehradun.

Anatomy of Wood- its Diversity and Variability by Wilson K and D.J.B. White.

The chemistry of solid wood by Roger Rowell.

Principles of wood Science & Technology-I Solid Wood by Kollmann FP & Widfred A. Cote Jr.

The chemistry of Natural Products (Vol.-II): The Natural Pigments by K.W. Bentley.

The chemistry of plant gums and mucilages by F. Smith and R. Montyomery.

Wood chemistry: Fundamentals and applications by E.S. Jostrom.

Methods of wood chemistry (Vol. I and II) by B.L. Browning organic chemistry by R.T. Morisson and R.N. Boyd.

MAJOR COURSES:

SAF-521: Modern Nursery Technology 3(2+1)

Objective:

To impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of green house, mist chamber and fertilizer use.

Theory

UNIT I

Seed collection and Storage,-Methods steps. Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery.

UNIT II

Bare root nursery- nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and outplanting.

UNIT III

Containerized nursery - Type and size of container including root trainers, selection of growing medium.

UNIT IV

Types of green house and mist chamber for propagation. Vegetative propagation - importance, selection of superior phenotype, methods of propagation viz., cutting, budding, grafting and layering. Factors affecting rooting of cuttings.

UNIT V

Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation.. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept.

Practical

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis.Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings. Use of vegetative propagation methods such as budding, grafting and layering. Precaution required in vegetative propagation, use of plant bio-regulators for rooting. Maintenance of nursery records. Identification of nursery insects and diseases and their control measures. Visit to nurseries.

Suggested Readings

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu, Dehradun

Dwivedi AP. 1993. *Forestry in India.* Surya Publ,New Delhi.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ, Jodhpur.

Ram Prakash, Chaudhari DC and Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors. Dehradun.

Dwivedi, AP. 1993. *A Text Book of Silviculture*: Inter Book Institute, Dehradun

Durya and Landis. *Forest Nursery Manual*

Aldhous JR. Nursery Practice (For common Bulletin Nov.3)

Evans J.1992. *Plantation Forestry in Tropics.* Clarendon Press,UK.

Viredra Singh and Lavamia SK. 2003. *Forest Tree Seeds and Nursery* Management. Bishen Singh Mahendrapal Singh, Dehradun

SAF-522: Plantation Forestry 3(2+1)

Objective

To acquaint with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations.

Theory

UNIT I

Role of plantation forestry in meeting the wood demand – plantation forestry in India and abroad, purpose of plantation, factors determining scale and rate of plantation, land suitability and choice of plantation species

UNIT II

Production technology for quality planting stock, preliminary site preparation for establishing plantations, planting program, time of planting, planting pattern, spacing, planting methods.

UNIT III

Nutritional dynamics and irrigation of plantation, mechanization in plantation, protection and after care of plantation, pruning and thinning of plantation for quality wood production, rotation in plantation, failure of plantations, impact of interaction and integration of plantation forestry, protective afforestation, afforestation of inhospitable sites, ecological factors and long term productivity, sustainable yield from plantation.

UNIT IV

Case studies in plantations of Eucalyptus, Casuarina, Poplars, Acacias, Pine, Silver Oak, Gmelina, Teak, Sandal, Bamboo, etc.

UNIT V

Wasteland plantations.

UNIT VI

Industrial Plantations.

Practical

Analysis of plantation problems in Asia and India – preparation of plantation calendar –preliminary arrangement for a plantation programme –planting geometry and calculation of planting stock – study of different cultural operations and site preparation for plantation – studies on wood based industries – problems and prospects – management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and bamboo plantations – production technology for energy plantations – INM in plantations – irrigation and plantations – economics of pulpwood, timber and energy plantations.

Suggested Readings

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.New Delhi

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ,Jodhpur.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors, Dehradun

Ram Prakash, Chaudhari DC and Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors, Dehradun.

SAF-523: Energy Plantation and Bio-fuels 3 (1+1)

Objective:

To develop understanding about the scope and advantages of using and raising bio-energy plantations.

Theory

UNIT I

Introduction and advantages of energy plantations. Energy and biomass consumption patterns in India. Environmental impacts of biomass energy.

UNIT II

Energy plantation- high density short rotation plantations- petro crops- avenue plantations- Plantations as potential carbon sinks .carbon sinks- Economic factors in plantation development- social and cultural considerations**.** Monitoring and evaluation of Plantations.

UNIT III

Study of planting operations- study of tending techniques- Planting methods and techniques for different types of plantations including energy plantations, canal bank plantations –Match and pulp wood plantations- study of Forest Development Corporation ,Plantation journal.

UNIT IV

Assessment of bio-energy programmes in India. Power generation from energy plantation, producer gas. High Density Energy Plantations (HDEP). Land and biomass availability for sustainable bio energy. Impact of energy efficiency in power sector.

UNIT V

Need for research and development on environment friendly and socio economical relevant technologies. Energy from plants-problems and prospects. Petro-crops. Criteria for evaluation of different species for energy plantation.

UNIT VI

Recent energy technologies in the production of bio-fuels.

Practical

Identification of important fuel woods and petro-crops. Study on different bio fuels used in India. Determination of calorific value, moisture and ash content in biomass study of energy consumption pattern in rural and urban areas through survey. Visit to nearby Bio-energy units.

Suggested Readings

Evans, J. 1992. Plantation Forestry in the Tropics, 2nd edition. Oxford, UK, Clarendon Press.

Evans, J. and Turnbull, J.W. 2004. Plantation Forestry in the Tropics: The Role, Silviculture and Use of Planted Forests for Industrial, Social, Environmental and Agroforestry Purposes. OUP Oxford, 467p.

Chaturvedi AN. 1994. *Technology of Forest Nurseries.* Khanna Bandhu, Dehradun

Kumar V. 1999. *Nursery and Plantation Practice in Forestry*. Scientific Publ, Jodhpur

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors, Dehradun.

SAF-524: Seed Collection, Storage and Testing 3 (2+1)

Objective

To impart knowledge and develop understand about seed development in tropical, sub-tropical and temperate region, testing and certification.

Theory

UNIT I

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems limiting actors in tree propagation and afforestation.

UNIT II

Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/ fruit.

UNIT III

Modes of seed dispersal. Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing, stage methods and seed testing techniques.

UNIT IV

Seed certification.

UNIT V

Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment.

Practical

Identification of forest seeds. Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit. Tests of viability viz., cutting, hydrogen peroxide, excised tetrazolium, embryo, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests, recording, calculation and use of results of seed treatment.

Suggested Readings

Khullar P 2003. *Forest Seed*. ICFRE Publication, Dehradun.

Ram Prasad, AK Kandya. *Handling of Forestry Seeds*. Associated Publishing Company, the University of Michigan

Nayital, R K. *Seed Testing and Nursery Manual in India*

Visendra Singh and Lavaria SK *Forest Tree Seeds and Nursery Management.*

SAF- 531 Nutrient and Weed Management in Nursery and Plantation 3(2+1)

Objective

To disseminate knowledge about managing nurseries and plantations under optimal conditions.

Theory

UNIT I

History of nutrient management in forest nurseries and plantation. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/ Interactions. Concept of nutrient availability.

UNIT II

Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency factors.

UNIT III

Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers.

UNIT IV

Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable waste and their recycling.

UNIT V

Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weedicide classification, properties and their application.

Practical

Principles and methods of soil and plant analysis. Preparation of nutrient solutions. Practical application of fertilizers. Study of fertilizer response and diagnosis of deficiency symptoms. Fertilizer testing and pot experiments. Nursery inoculation techniques of bio-fertilizers. Methods of application of formulated products-seed treatment, root dip, suckers treatment, soil application, foliar application and combination of different methods.

Suggested Readings

Allen V and Barker 2007. *Handbook of Plant Nutrition*. Pilbeam London.

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.Dehradun.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.Jodhpur Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.Dehradun

Singh O and Negi M. 1993. *Bibliography on Biomass and Nutrient Cycling of Forest Species*. FRI Dehradun.

SAF-526: Soil and Water Management in Agroforestry 3(2+1)

Objective

To impart knowledge on soil and water management in Agroforestry including biogeochemical cycling of nutrients.

Theory

UNIT I

Composition of earth's crust, soil as a natural body – major components. Soil forming rocks and minerals; weathering and processes of soil formation. Soil structure-definition-classification-**type, class and grade of structure**-factors influencing genesis of soil structure, soil consistency, plasticity-Atterberg's constants

UNIT II

Importance of water, water resources in **Rajasthan.** Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – water budgeting– distribution of soil moisture –rooting characteristics – moisture extraction pattern.

UNIT III

Soil and water management –objectives and scope in relation to Agroforestry systems. Soil and water conservation , land classification and carrying capacity. Irrigation potential and methods. Optimization of water use in agroforestry systems and dry land farming.

UNIT IV

Soil water relations, moisture regimes and management techniques. Problem soils and their management, soil organisms and nitrogen fixation.

UNIT V

Biogeochemical cycling of nutrient including organic matter decomposition. Nutrients budgeting and soil productivity under different agroforestry systems.

Practical

Collection and preparation of soil samples, Description of soil profile in the field. Estimation of moisture, EC, pH, bulk density and particle density .Calculation of water storage and fluxes in the soil. Determination of "*in situ* infiltration rate of soils. Measurement and estimation of run-off. Mineral nutrient analysis of soil and plants. Study of biogeochemical cycles in agro-forestry systems.

Suggested Readings

Biswas, T.D. and Mukherjee, S. K. 1987. Test Book of Soil Science, Tata McGraw Hill Publishing Co., New Delhi

Brady, N. C. 1990. Nature and Properties of Soils. 10th ed., Macmillan Publishing Co. Inc., New York

Michael, A.M. 2015. *Irrigation Theory and practices*. Vikas publishing house Pvt., Ltd.

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer, The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI UK..

SAF -527: Agroforestry System 3(2+1)

Objective

To impart knowledge on the concept of agroforestry land use including diagnosis and design methodologies.

Theory

UNIT I

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation.Classification of agroforestry systems – structural, functional, agro-ecological, socio-economic and physiognomic basis.

UNIT II

Overview of global agro-forestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Production potential of different silvi-pasture system.

UNIT III

Concepts of community forestry and social forestry, linear strip plantations.Major Agroforestry practices in different agroecological zones of India- arid and semi arid regions- agroforestry practices for wasteland reclamation. Agroforestry practices for salt affected soils – Agroforestry practices for wetlands and waterlogged areas. Non-wood forest products based agroforestry – Soil fertility improvement and water conservation through agroforestry

UNIT IV

Diagnosis and Design – Trends in Agroforestry systems research and development.National Agroforestry Policy 2014,National and International organizations in Agroforestry. Climate change risk on farming and forests, Recent trends in agroforestry systems.

Practical

Survey and analysis of land use systems in the adjoining areas. Design and plan of suitable models for improvement.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF- 528: Economics of Agroforestry Systems 3(2+1)

Objective

To acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems.

Theory

UNIT I

Economics- Meaning, definition, subject matter- Divisions of economics - Importance of economics- Forest Economics, Consumer behavior and Price Theory.

UNIT II

Basic principles of economics applied to agro-forestry. Optimization techniques- Planting, budgeting and functional analysis. Role of time, risk and uncertainty in decision making.

UNIT III

Financial management – financial statements and ratios, capital budgeting. Project management – project preparation and evaluation measures.Financial and socio-economic analysis of agro-forestry projects.

UNIT IV

Principles of financial management and harvesting, post harvest handling marketing of agro-forestry products including benefit sharing.

UNIT V

Marketing- definition – Marketing Process – Need for marketing – Role of marketing — Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agroforestry produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Exercises on agro-forestry production relationships. Preparation of enterprise, partial and complete budgets. Application of various methods in formulation and appraisal of agro-forestry projects. Case studies on harvesting, post harvest management and marketing of agro-forestryproducts. . Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF-529: Fruit Plants, Trees and shrubs for Agroforestry 3(2+1)

Objective

To make students familiar with trees and shrubs (fruit, fodder and small timber) suitable for agroforestry.

Theory

UNIT I

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agro-forestry systems. Fodder from trees/shrubs and their nutritive value propagation techniques.

UNIT II

Fruits crop and their need and relevance in Agroforestry fruit tree species suitable for various assemblage and then planting plan in different agro climatic situation and Agroforestry system. Modification in tending and pruning floor. Fertility management, yield and quality improvement.

UNIT III

Role of nitrogen fixing trees/ shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of tree and shrubs for Agroforestry. Generic and specific characters of trees and shrubs for agro-forestry.

Practical

Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry. Planting plans including wind breaks. Training and pruning of tree, shrubs and fruit trees for enhancing production in Agroforestry system.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF- 532: Management of Insect-Pests and Diseases in Forestry 3(1+1)

Objective

To impart knowledge about maintaining plantations and forests under disease free conditions.

Theory

UNIT I

Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases.

UNIT II

Importance of entomology in different fields. Definition, division and scope of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetalia. Structure, function of cuticle &moulting and body segmentation, Anatomy of digestive, Circulatory, Sensory, respiratory, glandular, excretory, nervous and reproductive systems. Types of reproduction.Important insects and pests of FOREST Nurseries and Forests/Plantations.

UNIT III

Principles and methods of integrated pests management – physical, cultural, chemical and biological methods. Use of attractants and repellants. Male sterility techniques.

UNIT IV

Diseases of forest nurseries and plantations. Abiotic agents of tree diseases and their relationship with hosts. Methods of disease control – exclusion, cultural, biological and chemical.

UNIT V

Rodents, Birds, squirrels, herbivores. Forest plant quarantine.

Practical

Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship.Collection and identification of insects and non-insects. Inspection and collection of damaged material showing insect damage. Identification and use of plant protection equipments. Preparation of different concentrations of pesticides and Identification of important diseases in forest nurseries and plantations. Preparation of fungicidal concentrations and their use in controlling nursery and plantation.

Suggested Readings

Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.

Mehrotra, R.S. and A. Agarwal. Plant Pathology (2nd Edition) . Tata McGraw-Hill Publishing Company Limited, New Delhi. 846 p.

Evane JW. 1989. *Insect Pest and their Control*. Samir Book Center, Delhi.

Phillip DM. 1982. *Diseases of Forest and Ornamental Trees*. MacMilan.

Speight MR and Whylie F R. 2012. *Insect Pest in Tropical Forestry*. ACIAR

SAF 534: Crops and Animal Production Management in Agroforestry 3(2+1)

Objective

To impart knowledge on interactions between tree and live stock including their management, principles of crops and fodder production in Agroforestry

Theory

UNIT I

Choice of inter-crops for different tree species, sowing and planting techniques. Planting patterns, crop geometry, nutrient requirements, and weed management. Management of fodder tree species, thinning, lopping, pruning. Ecological and socio-economic interactions

UNIT II

Role of tree architecture and its management on system's productivity. Production potentials of fodder based agroforestry systems in different agro climatic conditions. Crop combination, crop combination interactions in crop mixtures. Importance of cattle –sheep and goat vis-à-vis agro-forestry systems. Feed and fodder resources in agro-forestry systems and live stock management.

UNIT III

Nutrient analysis of forages derived from fodder trees/shrubs. Nutrient requirement for various livestock and their ration computation with Agroforestry forages and tree leaves. Forage and tree leaves preservation.

UNIT IV

Calendars for forage crop production in agro-forestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing.

UNIT V

Integrated Agroforestry Farming System

Practical:

Measurement of crop growth rates. Study of tree crop association and management methods. Quantitative evaluation of tree-crop, livestock, Analysis of forages and feeds for mineral and incrementing constituents. Digestibility of some agro-forestry forages. Preparation of leaf meal and forage conservation. Familiarity with common veterinary instruments, AI equipments and common feeds and fodders and Field visits.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF-535: Rangeland and Pasture Management 3(2+1)

Objective

Importance of rangeland, components of rangeland their characteristics and distribution, major types of rangeland in world and their characteristics, types of grasslands in India.

Theory

UNIT I

Concept of watershed management. Ideo-types of watershed development plans and activities for the watershed. Criterion for watershed size determination.

UNIT II

Principles and practices of range land management. Improvement of range productivity by vegetation manipulation through control of undesirable vegetation, burning, fertilization, soil and water conservation and protection. Range improvement and livestock management.

UNIT III

Feeding habits and grazing behavior of range livestock. Optimal livestock and range utilization, fodder from trees/shrubs and their nutritive values, propagation techniques, Micro climatic studies, root behavior, crown architecture including methods for minimizing unfavorable interactions.

UNIT IV

Production potential of different silvi-pasture systems, components of Silviculture. Pasture Management and its benefits, BMP (Best Management Practices) suitable species for Pastures for local and adjoining area of Rajasthan, Pasture rotation, Sustainable Pasture Management,

UNIT V

Characteristics of a watershed and their role in watershed management. Quantification of the benefits and effectiveness of the package of practices adopted for management of watershed, Dynamics vis-à-vis plant growth and post harvest processing for evaluation of chemical constituents.

UNIT VI

Biological and engineering approach in the management of degraded and denuded habitats as an integrated and multiple approach. SPP Testing. Provenance trials. Seed certification and storage. Elite trees selection. Range plant physiology –basic concepts, wood cycle and growth, carbohydrate reserves, determination of stocking - by forage production, livestock productivity and economic return. Effect of fire, grazing and fertilizes on plant growth. Range inventory and mapping, Types and their purpose, factors elaborated in a range inventory, grazing surveys, grazing capacity- its determination, range condition analysis.

Practical

Study of rangeland and pastures in and around the area. Identification of feedstuff and their nutritive value. Nutritive requirements of livestock. Study of hey and Silage.Cultivation practices of important fodder grasses and legumes of locality.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

MINOR COURSES:

STAT-512: Statistical Methods and Computer Application 3(2+1)

Objective

To impart basic knowledge in the student about statistical methods and application of computers in their research field.

Theory

UNIT I

Need for statistics in forestry experimentation and planning – population and sample. Correlation and regression: correlation coefficient/coefficient of determination, simple regression analysis; examples of multiple regressions. Examples of linear regression and its fitting by least square method.

UNIT II

Normal distribution and its application in forestry - properties of normal distribution. Confidence limits. Expected value of mean and standard error.

UNIT III

Tests of significance - Test for means in one sample and two sample cases (Z and t tests). Z-test for proportion, Chi-square test of variance in one sample case. F-test of variance in two sample cases. Test of equality of K - means (one way and two way classification). Probability, basic laws of probability.

UNIT IV

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.

UNIT V

Need for sampling in forestry. Complete enumeration Vs partial enumeration. Principal steps in sample surveys, population, sampling unit, size of sample, (sample intensity) bias, accuracy and precision. Sampling variation and estimation of sampling error. Determination of sample *size* for a given level. Classified sampling design used in forest surveys. Simple random sampling - stratified random sampling. Systematic sampling - Point sampling.

UNIT VI

Basic principles of design of experiments, Uniformity trials and their uses, Fair field Smiths Variance Law and optimum size and shape of plots. Design and analysis of C*.R.D.* R.B.D. and L.S.D. with one observation per cell. Factorial experiments: Symmetrical and Asymmetrical factorial experiments, 2^n factorial experiments, Yates method and general method of analysis of AxB and AxBxC factorial experiments. Layout and analysis of Split and Strip plot design. Missing plot technique in R.B.D. and L.S.D. with one observation missing.

UNIT VII

Transformations: Square root, Logarithmic and Angular transformation.

UNIT VIII

Introduction to computer, MS Office, Statistical Application packages like MS-Excel, SPSS, R-software.

Practical

Laying out of designs in the field. Analysis of 2^2 and 2^3 experiments in R.B.D., Analysis of AxB factorial experiments. Analysis of AxBxC factorial 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. Analysis of results of the above design, Application of Statistical Packages like MS-Excel, SPSS, R-software with real forestry data.

Suggested readings

V.G. Panse and P.V. Sukhatme (1985). Statistical Methods for Agricultural Workers. ICAR, New Delhi.

S.C. Gupta and V.K. Kapoor (2014). Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi.

Sukthame and C. Ashok (1984). Sampling Theories and Surveys with Application. ICAR, New Delhi, 3rd ed.

G.N. Rao (1983). Statistics for Agricultural Science. Oxford and IBH, New Delhi.

Das, M.N. and Giri. N.C. (1986). Design and analysis of Experiments. New Age International Publishers.

Kingra, H. S., Singh, G. (1993). Computer Basics for forestry, International Book Distributors, Dehradun.

Rajaraman, V and Adabala, N. (2015). *Fundamentals of Computers,* Pearson Education, New Delhi.

NRM- 511: Forest Soil and Land Reclamation 3(2+1)

Objective

To develop understanding and management skills of the students for forest soils and land reclamation practices

Theory

UNIT I

Introduction; Forest soil and its classification, soil forest types, Forest soils vs. cultivated soils. Genesis of forest soils, Properties of soils under different forest ecosystems.

UNIT II

Soil and tree planting, Amelioration of forest soils. Characterization of wasteland, present status and extent of non-arable lands and their productivity.

UNIT III

Salt affected soils, lateritic, marsh and swampy and rocky hills, rocky plains, murrammy and sandy soils, their characteristics and reclamation.

UNIT IV

Sites with superficial impervious hard pan. eroded ravines and gullies, various techniques of afforestation of adverse sites, trees suitable for adverse sites.

UNIT V

Afforestation and reclamation of mine wastes. Stabilization of tailing dumps and prevention of dust pollution. Sewage water as source of tree nutrients.

Practical

Exercise on sampling methods; Exercises on land use classes; Exercises on light-spectral characteristics; Analysis of soil for Gypsum and lime requirement; Exercises on study of eroded soils; Study on types of pits and trenches, tree species suitable for mined out areas; Visit to nearest mined areas. Drainage and reclamation of water logged lands; Measurement of irrigation water by various method; Design of graded bunds; Design and layout of waterways; Survey design and layout of bench terraces; Design and layout of diversion channels; Study of different water harvesting structures; Land leveling and its cost estimation; Study of drip irrigation system; Study of sprinkler irrigation system; Study of pumping system; Economic analysis of wasteland development.

Suggested Readings

R.K.Luna 1996 *Plantation Forestry*
Wilde, S.A. 1994 *Forest soil and Forest growth*
Dewedi, A.P. 2002 *A Textbook of Silviculture*

NRM- 512: Land use and Watershed Management 3(2+1)

Theory

UNIT I

Soli and Land, Land use patterns in India and Rajasthan, Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency. Biota- vegetation types, distribution and utilization.

UNIT II

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity issues. Formulation of watershed projects (micro and macro watershed).

UNIT III

Components of natural resources for watershed management. Preparation techniques for micro plan of watershed. Impact assessment techniques for upliftment of socio-economic status and environment. Valuing Inputs and Outputs.

UNIT IV

Watershed survey, mapping and structural engineering designs-Compass, Surveying, Plane table surveying, Leveling, Preparation of contour maps of watershed. Terraces and bunds- types & design.

UNIT V

Soil and water conservation and water harvesting structures – types & design. Sedimentation- sources, estimation of sediment bank treatment techniques. Hydrological cycle and characteristics of small and medium watersheds precipitation, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water and evapo-transpiration. Resources inventory soil, land, water and Biota.

UNIT VI

People participation and impact analysis in watershed management- Community organizations – Definition, Principles advantages, Community mobilization. Psychodynamics of group processes decision making, leadership, and conflict management and group strategies. Participatory planning, implementation, monitoring and evaluation. Participatory research approaches. Socio economic impact analysis, financial analysis.

Practical:

Survey of watershed, Preparation of micro-plan and planning of watershed for effective implementation. Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Study of flood control reservoirs; Exercises on economic profitability of various land-based enterprises bases in cost and revenue concepts. Preparation of contour maps, Estimation of earth work, Design of check dams, Acquaintance with water lifting devices, Use of measurement, Conveyance and control structures.

Suggested readings

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Murty, J.V.S. 1995. *Watershed Management in India.* Wiley Eastern, New Delhi.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture),Associated Pubg Co., Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

5.Dhuruva Narayana, V.V., Sastry, G. and Patnaik, V.S. 1990. *Watershed Management.* ICAR Publication, New Delhi.

NRM-531: Remote Sensing and Geographic Information System 3 (2+1)

Objective

Importance Remote sensing, components of Digital image processing, image analysis and classification, Use of GIS and GPS. Use of GIS software in Forestry.

Theory

UNIT I

Orientation to subject- use History and use of aerial photography, Satellite imagery and geographic information system

UNIT II

GIS for the collection, storage and spatial analysis for geo-referenced forest resources data and information.

UNIT III

The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management

UNIT IV

Satellite systems; satellite imageries – techniques, uses and limitation, Future prospects of remote sensing in India

UNIT V

Software used in remote sensing ; GIS versus remote sensing; GIS Software used in forestry and environments, Analysis of data; Application of GIS in forestry

Practical

Uses of various photogrammetry instruments, Recognition and identification of objects on photography, Compilation of maps and their interpretation, Hands on practice on remote sensing software, Hands on practice on GIS software

Suggested Readings :

Burrough P.A.1990. *Principles of GIS for Land Resources Assessment*. Oxford and IBH.

Lillsand T. M.1989. Remote Sensing and Image Interpretation. John Wiley.

Narayanan L.R.A. 1999. Remote Sensing and its application. University Press(India)/Orient Longman.

Sharma, N. K. 1986. Remote Sensing and Forest Survey. IBD, Dehradun.

SAF-511: Forests and Climate Change 3 (2+1)

Objective

Importance of forests and vegetation in the present era of climate change.

Theory

UNIT I

Weather and Climate, Climatic zones of India. Evaporation and transpirationcomponents of atmosphere, hydrosphere, pedosphere, biosphere and their interactions. Ecosystems of the world, Climate and its impact on agriculture, agro-climatic regions, soils and cropping patterns of India and agriculture productivity.

UNIT II

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest

UNIT III

Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on forests and agro-forestry- Climate resilient forestry.

UNIT IV

Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change.

UNIT V

National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere. Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer.

Suggested Readings

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and ForestGenetic Diversity: Implications for Sustainable Forest Managementin Europe*. Biodiversity International, Rome, Italy.

Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and ForestGenetic Diversity: Implications for Sustainable Forest Managementin Europe*. Biodiversity International, Rome, Italy.

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Mavi, H.S. (1994) Agrometerology . Oxford &IBH, New Delhi

Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,

Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg

Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR , New Delhi.

SAF- 533: Forest Policy, Laws and International Conventions 3(2+1)

Objective

To develop understanding of students about forest policy and laws and international conventions

Theory

UNIT I

Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988; Environment policy 2006, Agriculture policy, Policy on abetment of Pollution, National Eco tourism Policy ,National Tourism Policy, National Trade Policy, National Water Policy etc. Land Use Policy, Industrial Policy, Policy on resettlement and rehabilitation .

UNIT II

General principles of criminal law; Indian Penel Code, criminal procedure code; Indian evidence act applied to forestry matters.

UNIT III

Forest laws; Indian Forest Act –1927, general provision and detailed study; Forest Conservation Act 1980, Important Forest Rules and Guidelines. Wildlife Protect Act 1972, Biodiversity act 2002, Biodiversity Rules 2004, Plant Varieties Protection and Farmer's Rights Act 2001, Geographical Indications of Goods Act 1999. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, Water (Preventing and Control of Pollution) Act 1974; Air (Prevention and Control of Pollution) Act 1981; Environment (Protection) Act 1986, etc.

UNIT IV

International conventions- Convention on Biological Diversity 1992 (CBD) Cartagena Protocol on Bio-Safety 2000 (CPB), United Nation Framework Convention on ClimateChange, Kyoto Protocol, WTO and Environment, TRIP and Patenting Issues. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES),

UNIT V

Ramsar Convention on Wet Lands, The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal , The Montreal Protocol , IPCC, ICCD, etc. Important forestry institutions, case studies and landmark judgments.

Practical

Study of procedure for seizure of property. Visit to forest department and courts to observe penalty procedures. Preparation of first information report and enactment report. Study of working plans of the forests and to prepare the working plan for one of the area in the range.

Suggested Readings

Indian Forest Acts (with short notes)1975. Allahabad Law Agency.

Jha LK. 1994. *Analysis and Appraisal of India's Forest Policy.* Ashish Publ. House.

National Forest Policy 1952. Ministry of Food and Agriculture, New Delhi.

National Forest Policy 1988. Ministry of Environment and Forests, New Delhi.

Negi SS. 1985. *Forest Law*. Natraj Publ.

Saharia VB. 1989. *Wildlife Law in India*. Natraj Publ.

SAF- 512: Ecotourism and Participatory Forestry 3(2+1)

Theory

UNIT I

Eco tourism - study history of tourism- identify various forms of tourism and evolution of ecotourism. Mass tourism versus ecotourism. Organized tours and Free Independent Travelers.

UNIT II

World Tourism Organization. Problems with definition of ecotourism and criticisms. Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Different forms of ecotourism like hard and soft ecotourism.

UNIT III

Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism. Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context. Planning ecotourism in protected areas. - Visitor management in ecotourism areas - zoning, carrying capacity.

UNIT IV

Participation of local people in ecotourism.,PRA and RRA, Ecotourism for sustainable development of PA's. New directions in ecotourism industry. Ecotourism in practice in important PA's of India - case studies Limitations and problems of ecotourism.

UNIT V

Ecotourism as a way for sustainable management of natural resources. Local livelihoods and eco-tourism like nomadic grazing, agro- pasturatism).Desiging and landscaping in ecotourism. Design and management of ecotourism. Economics of ecotourism. Modern Research approaches on Eco-tourism.

Practical

Students should make detailed reference on the various forms of Ecotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism. Problems on common property resources and facilitate group discussion for recommendations. Evaluation and monitoring of the various ecotourism activities of the region such as Nature Walk - The guided day trek, The Tiger Trail, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage, Jungle Inn, The Sacred groves, Bamboo Grove, Green Mansions, the backwater cruise. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area, evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*.Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

SAF- 536: Production Management in Nursery and Plantation Forestry 3(2+1)

Objective

To develop understanding and management skills of the students in respect of commercial nursery production and plantation forestry.

Theory

UNIT I

Introduction to production theory. Production concepts, Resource-Product Relationship, Types and Kinds of Production Functions, Principles of choice and resource allocation in nursery production, Resource combination and cost minimization, Resource allocation and enterprise combination. Technical and economic efficiency, Derivation of cost and supply functions from production functions, break-even analysis managing risk and uncertainty in nursery and plantation forestry.

UNIT II

Planning and budgeting techniques applied in nursery production and plantation forestry. Record book keeping system. Income and cash flow analysis.

UNIT III

Time value of money, Principles of financial analysis, Investment analysis in plantation forestry, Determination of optimum rotation period.

UNIT IV

Market structure, Functions, Channels, Marketing efficiency and marketing problems of nursery and plantation forestry.

Practical

Exercises on marginal analysis in nursery production, Exercises on time-value of money and investment analysis. Exercises on marketing channels, costs, margin and price spread for different nursery and plantation crops.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*.Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997.

Natural Resource Economis – Theory and Application in India. Oxford & IBH. Dehradun

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988.*Forest Economics - Principles and Applications*. Natraj Publ.dehradun

Sharma LC. 1980.*Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. OxfordUniv. Press

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

Objective

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

Practical

Technical Writing

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, 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 article.

Communication Skills

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

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins, London

Gordon HM and Walter JA. 1970. *Technical Writing.* 3rd Ed. Holt, Rinehart and Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English.* 6th Ed. Oxford University Press, Oxford

James HS. 1994. *Handbook for Technical Writing.* NTC Business Books.

Joseph G. 2000. *MLA Handbook for Writers of Research Papers.* 5th Ed. Affiliated East-West Press.

Mohan K. 2005. *Speaking English Effectively.* MacMillan India.

Richard WS. 1969. *Technical Writing.* Barnes & Noble.

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language.* Abhishek. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English.* 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition.* S. Chand & Co. New Delhi.

PGS-503: e course-Intellectual Property and its Management in Agriculture (1+0)

Objective

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

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology.* CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy.* McGraw-Hill, New Delhi.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

Ministry of Agriculture, Government of !ndia. 2004. *State of Indian Farmer.* Vol. V. *Technology Generation and IPR Issues.* Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics.* CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies.* Daya Publ. House, New Delhi.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS-506: Disaster Management 1 (1+0)

Objectives

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Gupta HK. 2003. *Disaster Management.* Indian National Science Academy. Orient Blackswan.

Hodgkinson PE and Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management.* Routledge, London.

Sharma VK. 2001. *Disaster Management.* National Centre for Disaster Management, India.

FORT-451: Practices of Silviculture 3 (2+1)

Objective

To acquaint the students about general practices of silviculture in India and Rajasthan with examples of important trees.

Theory

UNIT I

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT II

Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration.

UNIT III

Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

UNIT IV

Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration- accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

UNIT V

Tree planting- Sowing v/s planting different kinds of pits. Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

UNIT VI

Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations, -objectives and uses

Practical

Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices.* Oxford and IBH, New Delhi.

Khanna LS. 1996. *Principle and Practice of Silviculture.* International Book Distributors, Dehradun.

Dwivedi AP. 1993. *A Text Book of Silviculture.* International Book Distributors, Dehradun

Khanna L. 1996. *Principles and Practices of Silviculture.* International Book Distributors, Dehradun

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-applied Forest Ecology.* John Wiley and Sons, New York.

FORT-452: Forest Products and Utilization 3 (2+1)

Objective

To acquaint the students about various forest products, availability of raw material and best utilization practices in India.

Theory

UNIT I

Introduction, methods of collection, management and importance of Non-Wood Forest Products (NWFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non Essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees.

UNIT II

Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits and vegetables, spices, poisons and bio-pesticides. Honey, Lac, and silk- their importance, extent and processing.

UNIT III

Pulp and paper industry. Introduction and raw material; pulpingmechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT IV

Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board.

UNIT V

Adhesives used in manufacture of composite wood. Improved wood , definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood. Production of wood molasses, alcohol and yeast.

Practical

Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

Suggested Readings

Anonymous. 1981. *Wealth of India.* CSIR Publ., New Delhi.

Anonymous. 2007. *Year Book of Forest Products.* FAO.

Dwivedi AP. 1993. *Forestry in India.* Surya Publ., New Delhi.

FORT-453: Dendrology and Forest Botany 3 (2+1)

Objective

To acquaint the students about various forest plants and trees, their identification and systematic.

Theory

UNIT I

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems.Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature.

UNIT II

Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc.

UNIT III

Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts.

UNIT IV

Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system.

UNIT V

Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Santalaceae, Papilionaceae, Caesalpiniaceae Mimosaceae, Elaeagnaceae, Meliaceae, Salicaceae, Rutaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Asteraceae, Moraceae, Poaceae, Tiliaceae, Euphorbiaceae, Myrtaceae and Combretaceae, Liliaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae,.

UNIT VI

Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. Study of woody flora of: Magnoliaceae, Ebenaceae and Tiliaceae; Papilionaceae, Caesalpiniaceae and Mimosaceae;; Moraceae and Poaceae; Meliaceae, and Salicaceae; Apocynaceae; Combretaceae, Myrtaceae and Santaleceae; Asteraceae, Sapotaceae and Verbenaceae; Euphorbiaceae and Liliaceae.

Suggested Readings:

Bhandari, M.M. (1978). Flora of Indian Desert, Scientific Pub., Jhodhpur, Pp. 471.

Bor, N.L. (1996) Manual of Indian Forest Botany, IBD Pub., Dehradun, Pp. 441.

Brandis, D. (1874). The Forest Flora of North-west and Central India (Repr. Ed. 1972). Bishen Singh & Mahendra Pal Singh, Dehradun, India.

Dasgupta, S. (1988). Systematic Botany for Foresters, Khanna Bandhu Pub., Dehradun, Pp. 210.

Harlow, William M., Editor (1995). Textbook of Dendrology, Authors, Ellwood S. Harrar, James W. Hardin, Fred M. White), McGraw-Hill Companies, Pp. 534.

Krishen, Pradeep (2006). Trees of Delhi-A Field Guide, DK Pub., India, Pvt. Ltd. New Delhi, Pp.360.

Kumar, Ashok (2001). Botany in Forestry and Environment, Kumar Media Pvt. Ltd., Dehradun, Pp. 716.

Naik V. N. (2003). Taxonomy of Angiosperms,

Pandey, B.P. (1978). Economic Botany, S Chand Pub., Pp.534.

Sharma, N. (2002). The Flora of Rajasthan, Avishkar Pub Distributors, Jaipur, Pp.208.

Singh, V. and D.K. Jain (2006). Taxonomy of Angiosperm**.**

SYLLABUS

For

M.Sc. Forestry (Silviculture and Agroforestry)

2018-19

FACULTY OF FORESTRY

DEPARTMENT OF SILVICULTURE AND AGROFORESTRY

COLLEGE OF HORTICULTURE AND FORESTRY,

JHALARAPATAN, JHALAWAR

(AGRICULTURE UNIVERSITY, KOTA)

M.Sc. Forestry (Silviculture and Agroforestry)
Semester-wise Distribution of Courses

Semester I

Course Code	Course Title	Credit Hours
FORT-511	**Silviculture and Forest Biometry**	3 (2+1)
FORT-512	**Forest Management and Protection**	3 (2+1)
FORT-513	**Tree Physiology and Tree Improvement**	3 (2+1)
STAT- 512	Statistical Methods and Computer Application	3 (2+1)
*NRM-511	Forest Soil and Land Reclamation	3 (2+1)
*NRM-512	Land use and Watershed Management	3 (2+1)
*SAF-511	Forests and Climate Change	3 (2+1)
*SAF-512	Ecotourism and Participatory Forestry	3 (2+1)
FORT-451 (Deficiency course)	Practices of Silviculture	2+1 (NC)
****Any one course to be opted out of four***		
	Total Credit Hours of Courses	**15 (10+5)**

Semester II

Course Code	Course Title	Credit Hours
*SAF- 521	Modern Nursery Technology	3 (2+1)
*SAF- 522	Plantation Forestry	3 (2+1)
*SAF- 523	Energy Plantations and Bio-fuels	3 (2+1)
*SAF- 524	Seed Collection, Storage and Testing	3 (2+1)
*SAF- 526	Soil and Water Management in Agroforestry	3 (2+1)
*SAF- 527	Agroforestry Systems	3 (2+1)
*SAF- 528	Economics of Agroforestry Systems	3 (2+1)
*SAF- 529	Fruit Plants, Trees and Shrubs for Agroforestry	3 (2+1)
PGS 502	e-course -Technical Writing and Communication Skills	0+1 (NC)
FORT-452 (Deficiency course)	Forest Products and Utilization	2+1 (NC)
Any four courses to be opted out of eight** ***(SAF- 521, 522, 523 & 524 for students intending super specialization in Silviculture and SAF- 526, 527, 528 & 529 for students intending super specialization in Agroforestry)		
	Total Credit Hours of Courses	**12 (8+4)**

Semester-III

Course Code	Course Title	Credit Hours
FORT-531	**Forest Products – Chemistry and Industries**	3 (2+1)
*SAF- 531	Nutrient and Weed Management in Nursery and Plantation	3 (2+1)
*SAF- 532	Management of Insect Pest and Diseases in Forestry	3 (2+1)
*SAF- 534	Crops and Animal Production Management in Agroforestry	3 (2+1)
*SAF- 535	Rangeland and Pasture Management	3 (2+1)
**NRM-531	Remote Sensing and Geographic Information System	3 (2+1)
**SAF-533	Forest Policy, Law and International Conventions	3 (2+1)
**SAF-536	Production Management in Nursery and Plantation Forestry	3 (2+1)
PGS 503	e-course -Intellectual Property and its Management in Agriculture	1+0 (NC)
PGS -506	e-course -Disaster Management	1+0 (NC)
FORT-453 (Deficiency course)	Dendrology and Forest Botany	2+1 (NC)
SAF-591	Credit Seminar	1 (0+1)
**** Any one course to be opted from (SAF-531 & 532 for students intending super specialization in Silviculture and from SAF-534 &535 for students intending super specialization in Agroforestry)*** *****Any one course to be opted out of three***		
	Total Credit Hours of Courses	**10 (6+4)**

Semester-IV

Course Code	Course Title	Credit Hours
SAF-541	Comprehensive (NC)	1+0 (NC)
SAF-599	Research	20 (0+20)
	Total Credit Hours (I+II+III+IV) (14+11+12+20)	**57**

MASTER OF SCIENCE IN FORESTRY **(Silviculture and Agroforestry)**

COURSES APPROVED BY THE **10th Academic council** Meeting Held on **08th June '2018** as per Agenda item No. **AUK/AC-10/2018-01/11**

CORE COURSES	FORT - 511	Silviculture and Forest Biometry	3 (2+1)
	FORT - 512	Forest Management and Protection	3 (2+1)
	FORT - 513	Tree Physiology and Tree Improvement	3 (2+1)
	FORT - 531	Forest Products –Chemistry and Industries	3 (2+1)
		Total (Core Courses)	**12(8+4)**
* * MAJOR COURSES	SAF - 521	Modern Nursery Technology	3 (2+1)
	SAF - 522	Plantation Forestry	3 (2+1)
	SAF - 523	Energy Plantations and Bio-fuels	3 (2+1)
	SAF - 524	Seed Collection, Storage and Testing	3 (2+1)
	SAF - 531	Nutrient and Weed Management in Nursery and Plantation	3 (2+1)
	SAF - 526	Soil and Water Management in Agroforestry	3 (2+1)
	SAF - 527	Agroforestry Systems	3 (2+1)
	SAF - 528	Economics of Agroforestry Systems	3 (2+1)
	SAF - 529	Fruit Plants, Trees and Shrubs for Agroforestry	3 (2+1)
	SAF - 532	Management of Insect Pest and Diseases in Forestry	3 (2+1)
	SAF - 534	Crops and Animal Production Management in Agroforestry	3 (2+1)
	SAF - 535	Rangeland and Pasture Management	3 (2+1)
** *Any five courses to be opted* (as per semester distribution option)		**Total (Major Courses)**	**15 (10+5)**
MINOR COURSES	STAT-512	Statistical Methods and Computer Application	3 (2+1)
	*NRM-511	Forest Soil and Land Reclamation	3 (2+1)
	*NRM-512	Land Use and Watershed Management	3 (2+1)
	*NRM-531	Remote Sensing and Geographic Information System	3 (2+1)
	*SAF-511	Forests and Climate Change	3 (2+1)
	*SAF-533	Forest Policy, Law and International Conventions	3 (2+1)
	*SAF-512	Ecotourism and Participatory Forestry	3 (2+1)
	*SAF-536	Production Management in Nursery and Plantation Forestry	3 (2+1)
		**Any two courses to be opted*	
		Total (Minor Courses)	**9 (6+3)**
NON - CREDIT	PGS 502	Technical Writing and Communication Skills	0+1 (NC)
	PGS 503	e-course –Intellectual Property and its Management in Agriculture	1+0 (NC)
	PGS 506	e-course- Disaster Management	1+0 (NC)
***NON - CREDIT DEFICIENCY COURSES	FORT-451	Practices of Silviculture	3 (2+1)
	FORT-452	Forest Products and Utilization	3 (2+1)
	FORT-453	Dendrology and Forest Botany	3 (2+1)
	***Required to be offered by the students not having B.Sc. Forestry Degree Programme		
	SAF-591	Credit Seminar	1 (0+1)
	SAF-541	Comprehensive (NC)	1+0 (NC)
	SAF-599	*Research*	**20 (0+20)**
		Grand Total	57

CORE COURSES:

FORT-511: Silviculture and Forest Biometry 3 (2+1)

Objective

To provide knowledge about Forest ecosystem concept, stand dynamics-forest succession, productivity and vegetation forms and natural regeneration of tree species. To develop understanding of students about tree measurements, forest inventory and yield concepts

Theory

UNIT I

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

UNIT II

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT III

Natural regeneration of species and types including unevenaged silviculture. Intermediate treatments.

UNIT IV

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands,. Preparation of volume & its application, yield and stand tables.

UNIT V

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT VI

Growth and yield prediction models – their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practice*s. Oxford and IBH, New Delhi.

Dwivedi AP. 1993. *A Text Book of Silvicultur*e. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silvicultur*e. Khanna Bandhu, Dehradun.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons, US.

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuratio*n. International Book Distributor.

Ram Parkash 1983. *Forest Surveyin*g. International Book Distr., Dehradun.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestr*y. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuratio*n. Bishen Singh Mahender Pal Singh, Dehradun

FORT-512: Forest Management and Protection 3 (2+1)

Objective

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density and forest valuation. To provide knowledge to students about forest protection through diseases and pest management.

Theory

UNIT I

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT II

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies. Forest valuation and appraisal in regulated forests.

UNIT III

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management.

UNIT IV

Biodegradation of wood – microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots – factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health.

UNIT V

Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

UNIT VI

Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance trees.

Practical

Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Collection, identification and preservation of important insect pests and disease specimens of forest plants. Assessment of losses due to diseases, insect pests etc. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in nurseries and plantations, Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection.

Suggested Readings

Ajay S Rawat. 1991. *History of Forest in India.* Indus Pub. Co. New Delhi.

Avery and Burkhart. 2015. *Forest Measurement.* Waveland Press, Illinois.

Brasnet, NV.1953. *Planned Management of Forests*. George Allen & Unwin, London

Lawrance S. Davis and K.Morman Johson. 1987. *Forest Management*. McGraw-Hill the University of Michigan.

Maslekar.2008. *Management of Forests in India: New Opportunities*. Bishen Singh Mahendra Pal Singh, Dehradun.

Myth D Realty by J B Lal. *India's Forests*

Oliver, CD and Larson BC. 1996. *Forest Stand Dynamics*. John Wiley and Sons, New York.

Osmaston. 1968.*Management of Forest.* Hafner Pub. Co. New York.

Ram Parkash.1986. *Forest Management,* International Book Distributors, Dehradun.

Sharma, LC. *Forest Economics, Planning and Management*

Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.

Jha LK and Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House, New Delhi.

Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall, the University of Michigan.

Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.Bhopal.

FORT-513: Tree Physiology and Tree Improvement 3 (2+1)

Objective:

To acquaint the students about general principles tree physiology tree breeding with examples of important trees.

Theory

UNIT I

Introduction to tree physiology. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency..

UNIT II

Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Water relations of forest trees – Transpiration from forest canopies - Water use efficiency of forest stands. GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C,N,P,S. General concept of forest tree breeding, tree improvement and forest genetics.

UNIT III

Reproduction in forest trees, dimorphism pollination mechanism. Pollen dispersal, pollinators. Attractants for pollinators.

UNIT IV

Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races. Seed, seed formation, dispersal, storage and seed dormancy.

UNIT V

Selective breeding methods- mass, family, within family, plus within family. Plus tree selection for wood quality. Progeny and clone testing. Seed orchards – type, functions and importance. Estimating genetic parameters and genetic gain.

UNIT VI

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, Neem etc.

UNIT VII

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy. Biotechnology in tree improvement.

Practical

Estimation of stomatal index.Estimation of water potential in plants using Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, and LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc.Measurement of relative water content, leaf water potential, osmotic potential Observation on tree architecture of important species. Study of Floral biology of important trees in the region. Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones.. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids.

Suggested Readings

Hopkins, W.G. and Huner, N.P.A. (2008) Introduction to plant physiology. Wiley.

Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York

Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London

Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Managment. Academic Press Inc., London.

Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd. Singapore.

Mandal AK and Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN and Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

White TL, Adams WT and Neale DB. 2007. *Forest Genetics*. CABI, UK.

Zobel BJ and Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley and Sons.

FORT-531: Forest Products – Chemistry and Industries 3 (2+1)

Objective

The course will equip the students regarding wood based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this wood extracts resins and gums, katha, tannins and various types of non timber products. Practical will make them aware regarding extraction method of different products of wood.

Theory

UNIT I

Importance of forest based industries in relation to Indian economy. Chemistry in relation to forest products

UNIT II

Description of different forest based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of woods of lesser known forest species for commercial purposes.

UNIT III

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood - water and organic solvent soluble. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT V

Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest based dyes and pigments.

Practical

Estimation of cell wall contents - Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood. Visit to nearby forest based industries.

Suggested Readings

Principles of Eood Science and Technology (Solid wood) Vol. I & II by FP Kollmann and Wilfred A. Cote Jr.

Indian Forest Utilization, Vol. I FRI Dehradun Publication.

Text Book of Wood Technology by A.J. Panshin and Carlde Zeeuw.

An Introduction to Plant Anatomy by Arthur J. Eames and Lausence H. McDaniel.

Indian Forest Utilization Vol. I FRI Dehradun, Publication.

A key of Identification of Fifty Important Timbers of India, FRI, Dehradun.

Anatomy of Wood- its Diversity and Variability by Wilson K and D.J.B. White.

The chemistry of solid wood by Roger Rowell.

Principles of wood Science & Technology-I Solid Wood by Kollmann FP & Widfred A. Cote Jr.

The chemistry of Natural Products (Vol.-II): The Natural Pigments by K.W. Bentley.

The chemistry of plant gums and mucilages by F. Smith and R. Montyomery.

Wood chemistry: Fundamentals and applications by E.S. Jostrom.

Methods of wood chemistry (Vol. I and II) by B.L. Browning organic chemistry by R.T. Morisson and R.N. Boyd.

MAJOR COURSES:

SAF-521: Modern Nursery Technology 3(2+1)

Objective:

To impart knowledge on modern nursery techniques about types of nursery, vegetative propagation, use of green house, mist chamber and fertilizer use.

Theory

UNIT I

Seed collection and Storage,-Methods steps. Introduction and importance of nursery. Types of nurseries. Bare root, containerized and vegetatively produced nursery.

UNIT II

Bare root nursery- nursery soil and water management, bed preparation, pre sowing seed treatments, seed sowing and intermediate operations viz., pricking, watering, fertilization, weeding and hoeing. Physiology and nursery environment interaction affecting seedling growth. Root culturing techniques. Lifting windows, grading, packaging and storing and outplanting.

UNIT III

Containerized nursery - Type and size of container including root trainers, selection of growing medium.

UNIT IV

Types of green house and mist chamber for propagation. Vegetative propagation - importance, selection of superior phenotype, methods of propagation viz., cutting, budding, grafting and layering. Factors affecting rooting of cuttings.

UNIT V

Structures, media fertilizers, sanitation and containers, source selection and management in vegetative propagation.. Study of important nursery pests and diseases and their control measures. Nursery practices for some important tree species. Target seedling concept.

Practical

Identification of seeds of tree species; Seed maturity tests; Physical purity analysis.Introduction and identification of modern equipments and tools used in nursery. Pre-sowing seed treatments. Preparation of nursery beds and growing media for containerized nursery. Sowing of seed and other intermediate nursery management operations. Preparation and planting of cuttings. Use of vegetative propagation methods such as budding, grafting and layering. Precaution required in vegetative propagation, use of plant bio-regulators for rooting. Maintenance of nursery records. Identification of nursery insects and diseases and their control measures. Visit to nurseries.

Suggested Readings

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu, Dehradun

Dwivedi AP. 1993. *Forestry in India.* Surya Publ,New Delhi.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ, Jodhpur.

Ram Prakash, Chaudhari DC and Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors. Dehradun.

Dwivedi, AP. 1993. *A Text Book of Silviculture*: Inter Book Institute, Dehradun

Durya and Landis. *Forest Nursery Manual*

Aldhous JR. Nursery Practice (For common Bulletin Nov.3)

Evans J.1992. *Plantation Forestry in Tropics.* Clarendon Press,UK.

Viredra Singh and Lavamia SK. 2003. *Forest Tree Seeds and Nursery* Management. Bishen Singh Mahendrapal Singh, Dehradun

SAF-522: Plantation Forestry 3(2+1)

Objective

To acquaint with various aspects of production, integrated nutrient and irrigation management and ecological factors in raising forest plantations.

Theory

UNIT I

Role of plantation forestry in meeting the wood demand – plantation forestry in India and abroad, purpose of plantation, factors determining scale and rate of plantation, land suitability and choice of plantation species

UNIT II

Production technology for quality planting stock, preliminary site preparation for establishing plantations, planting program, time of planting, planting pattern, spacing, planting methods.

UNIT III

Nutritional dynamics and irrigation of plantation, mechanization in plantation, protection and after care of plantation, pruning and thinning of plantation for quality wood production, rotation in plantation, failure of plantations, impact of interaction and integration of plantation forestry, protective afforestation, afforestation of inhospitable sites, ecological factors and long term productivity, sustainable yield from plantation.

UNIT IV

Case studies in plantations of Eucalyptus, Casuarina, Poplars, Acacias, Pine, Silver Oak, Gmelina, Teak, Sandal, Bamboo, etc.

UNIT V

Wasteland plantations.

UNIT VI

Industrial Plantations.

Practical

Analysis of plantation problems in Asia and India – preparation of plantation calendar –preliminary arrangement for a plantation programme –planting geometry and calculation of planting stock – study of different cultural operations and site preparation for plantation – studies on wood based industries – problems and prospects – management of Eucalyptus, Casuarina, Teak, Sal, Poplar, Acacias and bamboo plantations – production technology for energy plantations – INM in plantations – irrigation and plantations – economics of pulpwood, timber and energy plantations.

Suggested Readings

Dwivedi AP. 1993. *Forestry in India*. Surya Publ.New Delhi

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ,Jodhpur.

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors, Dehradun

Ram Prakash, Chaudhari DC and Negi SS. 1998. *Plantation and Nursery Techniques of Forest Trees*. International Book Distributors, Dehradun.

SAF-523: Energy Plantation and Bio-fuels 3 (1+1)

Objective:

To develop understanding about the scope and advantages of using and raising bio-energy plantations.

Theory

UNIT I

Introduction and advantages of energy plantations. Energy and biomass consumption patterns in India. Environmental impacts of biomass energy.

UNIT II

Energy plantation- high density short rotation plantations- petro crops- avenue plantations- Plantations as potential carbon sinks .carbon sinks- Economic factors in plantation development- social and cultural considerations**.** Monitoring and evaluation of Plantations.

UNIT III

Study of planting operations- study of tending techniques- Planting methods and techniques for different types of plantations including energy plantations, canal bank plantations –Match and pulp wood plantations- study of Forest Development Corporation ,Plantation journal.

UNIT IV

Assessment of bio-energy programmes in India. Power generation from energy plantation, producer gas. High Density Energy Plantations (HDEP). Land and biomass availability for sustainable bio energy. Impact of energy efficiency in power sector.

UNIT V

Need for research and development on environment friendly and socio economical relevant technologies. Energy from plants-problems and prospects. Petro-crops. Criteria for evaluation of different species for energy plantation.

UNIT VI

Recent energy technologies in the production of bio-fuels.

Practical

Identification of important fuel woods and petro-crops. Study on different bio fuels used in India. Determination of calorific value, moisture and ash content in biomass study of energy consumption pattern in rural and urban areas through survey. Visit to nearby Bio-energy units.

Suggested Readings

Evans, J. 1992. Plantation Forestry in the Tropics, 2nd edition. Oxford, UK, Clarendon Press.

Evans, J. and Turnbull, J.W. 2004. Plantation Forestry in the Tropics: The Role, Silviculture and Use of Planted Forests for Industrial, Social, Environmental and Agroforestry Purposes. OUP Oxford, 467p.

Chaturvedi AN. 1994. *Technology of Forest Nurseries.* Khanna Bandhu, Dehradun

Kumar V. 1999. *Nursery and Plantation Practice in Forestry*. Scientific Publ, Jodhpur

Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors, Dehradun.

SAF-524: Seed Collection, Storage and Testing 3 (2+1)

Objective

To impart knowledge and develop understand about seed development in tropical, sub-tropical and temperate region, testing and certification.

Theory

UNIT I

Introduction, trends and development in tropical, sub-tropical and temperate forestry and their influence on seed demand. Seed problems limiting actors in tree propagation and afforestation.

UNIT II

Flowering and seed production in gymnosperms and angiosperms. Development and maturation of seed/ fruit.

UNIT III

Modes of seed dispersal. Determining optimal harvest maturity indices. Factors influencing choice of collection methods. Methods of seed collection and processing, stage methods and seed testing techniques.

UNIT IV

Seed certification.

UNIT V

Eco-physiological role of seed storage. Classification of seed storage potential. Factors affecting seed longevity. Pre-storage treatment. Physiological change during ageing. Viability and vigor. Storage of orthodox, recalcitrant and pre-storage intermediate seeds, Fumigation and seed treatment.

Practical

Identification of forest seeds. Seed sampling, different storage methods, Seed quality testing-purity, viability and germination, collection and processing of seeds/ fruit. Tests of viability viz., cutting, hydrogen peroxide, excised tetrazolium, embryo, seed health testing primarily to the presence or absence of disease-caused organisms such as fungi, bacteria, virus and animal pests, recording, calculation and use of results of seed treatment.

Suggested Readings

Khullar P 2003. *Forest Seed*. ICFRE Publication, Dehradun.

Ram Prasad, AK Kandya. *Handling of Forestry Seeds*. Associated Publishing Company, the University of Michigan

Nayital, R K. *Seed Testing and Nursery Manual in India*

Visendra Singh and Lavaria SK *Forest Tree Seeds and Nursery Management.*

SAF- 531 Nutrient and Weed Management in Nursery and Plantation 3(2+1)

Objective

To disseminate knowledge about managing nurseries and plantations under optimal conditions.

Theory

UNIT I

History of nutrient management in forest nurseries and plantation. Essential nutrient elements and their deficiency. Mechanism of nutrient uptake by plants, functions and translocation/ Interactions. Concept of nutrient availability.

UNIT II

Climatic and soil conditions causing micronutrient deficiencies in plants. Occurrence and treatment of micronutrient disorders. Evaluation of soil for the supply of micronutrient. Rare and non-essential elements. Technology and use of complex liquid and suspension fertilizers. Fertilizer use efficiency factors.

UNIT III

Biological nitrogen fixation and bio-fertilizers. Farm yard manure and other organic fertilizers.

UNIT IV

Mycorrhizal associations and their significance. Economic implications of nutrient management. Importance of renewable waste and their recycling.

UNIT V

Principles of weed control. Methods of weed control-cultural, biological, mechanical and chemical. Herbicide/ weedicide classification, properties and their application.

Practical

Principles and methods of soil and plant analysis. Preparation of nutrient solutions. Practical application of fertilizers. Study of fertilizer response and diagnosis of deficiency symptoms. Fertilizer testing and pot experiments. Nursery inoculation techniques of bio-fertilizers. Methods of application of formulated products-seed treatment, root dip, suckers treatment, soil application, foliar application and combination of different methods.

Suggested Readings

Allen V and Barker 2007. *Handbook of Plant Nutrition*. Pilbeam London.

Chaturvedi AN. 1994. *Technology of Forest Nurseries*. Khanna Bandhu.Dehradun.

Evans J. 1982. *Plantation Forestry in the Tropics*. Clarendon Press, Oxford.

Kumar V. 1999. *Nursery and Plantation Practices in Forestry*. Scientific Publ.Jodhpur Luna RK. 1989. *Plantation Forestry in India*. International Book Distributors.Dehradun

Singh O and Negi M. 1993. *Bibliography on Biomass and Nutrient Cycling of Forest Species*. FRI Dehradun.

SAF-526: Soil and Water Management in Agroforestry 3(2+1)

Objective

To impart knowledge on soil and water management in Agroforestry including biogeochemical cycling of nutrients.

Theory

UNIT I

Composition of earth's crust, soil as a natural body – major components. Soil forming rocks and minerals; weathering and processes of soil formation. Soil structure-definition-classification-**type, class and grade of structure**-factors influencing genesis of soil structure, soil consistency, plasticity-Atterberg's constants

UNIT II

Importance of water, water resources in **Rajasthan.** Area of different crops under irrigation, function of water for plant growth, effect of moisture stress on crop growth. Available and unavailable soil moisture – water budgeting– distribution of soil moisture –rooting characteristics – moisture extraction pattern.

UNIT III

Soil and water management –objectives and scope in relation to Agroforestry systems. Soil and water conservation , land classification and carrying capacity. Irrigation potential and methods. Optimization of water use in agroforestry systems and dry land farming.

UNIT IV

Soil water relations, moisture regimes and management techniques. Problem soils and their management, soil organisms and nitrogen fixation.

UNIT V

Biogeochemical cycling of nutrient including organic matter decomposition. Nutrients budgeting and soil productivity under different agroforestry systems.

Practical

Collection and preparation of soil samples, Description of soil profile in the field. Estimation of moisture, EC, pH, bulk density and particle density .Calculation of water storage and fluxes in the soil. Determination of "*in situ* infiltration rate of soils. Measurement and estimation of run-off. Mineral nutrient analysis of soil and plants. Study of biogeochemical cycles in agro-forestry systems.

Suggested Readings

Biswas, T.D. and Mukherjee, S. K. 1987. Test Book of Soil Science, Tata McGraw Hill Publishing Co., New Delhi

Brady, N. C. 1990. Nature and Properties of Soils. 10th ed., Macmillan Publishing Co. Inc., New York

Michael, A.M. 2015. *Irrigation Theory and practices*. Vikas publishing house Pvt., Ltd.

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer, The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI UK..

SAF -527: Agroforestry System 3(2+1)

Objective

To impart knowledge on the concept of agroforestry land use including diagnosis and design methodologies.

Theory

UNIT I

Agroforestry objectives, importance, potential and impediments in implementation. Land capability classification and land evaluation.Classification of agroforestry systems – structural, functional, agro-ecological, socio-economic and physiognomic basis.

UNIT II

Overview of global agro-forestry systems, shifting cultivation, taungya system, multiple and mixed cropping, alley cropping, shelter-belts and windbreaks, energy plantations and homestead gardens. Production potential of different silvi-pasture system.

UNIT III

Concepts of community forestry and social forestry, linear strip plantations.Major Agroforestry practices in different agroecological zones of India- arid and semi arid regions- agroforestry practices for wasteland reclamation. Agroforestry practices for salt affected soils – Agroforestry practices for wetlands and waterlogged areas. Non-wood forest products based agroforestry – Soil fertility improvement and water conservation through agroforestry

UNIT IV

Diagnosis and Design – Trends in Agroforestry systems research and development.National Agroforestry Policy 2014,National and International organizations in Agroforestry. Climate change risk on farming and forests, Recent trends in agroforestry systems.

Practical

Survey and analysis of land use systems in the adjoining areas. Design and plan of suitable models for improvement.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF- 528: Economics of Agroforestry Systems 3(2+1)

Objective

To acquaint the students with principles of economics and use of economic tools in appraisal of the agroforestry systems.

Theory

UNIT I

Economics- Meaning, definition, subject matter- Divisions of economics - Importance of economics- Forest Economics, Consumer behavior and Price Theory.

UNIT II

Basic principles of economics applied to agro-forestry. Optimization techniques- Planting, budgeting and functional analysis. Role of time, risk and uncertainty in decision making.

UNIT III

Financial management – financial statements and ratios, capital budgeting. Project management – project preparation and evaluation measures.Financial and socio-economic analysis of agro-forestry projects.

UNIT IV

Principles of financial management and harvesting, post harvest handling marketing of agro-forestry products including benefit sharing.

UNIT V

Marketing- definition – Marketing Process – Need for marketing – Role of marketing — Marketing functions – Classification of markets – Marketing of various channels – Price spread – Marketing Efficiency – Integration – Constraints in marketing of agroforestry produce. Market intelligence – Basic guidelines for preparation of project reports- Bank norms – Insurance – SWOT analysis – Crisis management.

Practical

Exercises on agro-forestry production relationships. Preparation of enterprise, partial and complete budgets. Application of various methods in formulation and appraisal of agro-forestry projects. Case studies on harvesting, post harvest management and marketing of agro-forestryproducts. . Identification of marketing channel– Calculation of Price Spread – Identification of Market Structure – Visit to different Markets.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF-529: Fruit Plants, Trees and shrubs for Agroforestry 3(2+1)

Objective

To make students familiar with trees and shrubs (fruit, fodder and small timber) suitable for agroforestry.

Theory

UNIT I

Introduction, importance of woody elements in agro-forestry systems, their role in biomass production. Suitability of species for different purposes. Multipurpose trees in agro-forestry systems. Fodder from trees/shrubs and their nutritive value propagation techniques.

UNIT II

Fruits crop and their need and relevance in Agroforestry fruit tree species suitable for various assemblage and then planting plan in different agro climatic situation and Agroforestry system. Modification in tending and pruning floor. Fertility management, yield and quality improvement.

UNIT III

Role of nitrogen fixing trees/ shrubs. Choice of species for various agro climatic zones for the production of timber, fodder, fuel wood, fibre, fruits, medicinal and aromatic plants. Generic and specific characters of tree and shrubs for Agroforestry. Generic and specific characters of trees and shrubs for agro-forestry.

Practical

Field survey and acquaintance with specialized features of trees, shrubs and fruit species and varieties for Agroforestry. Planting plans including wind breaks. Training and pruning of tree, shrubs and fruit trees for enhancing production in Agroforestry system.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF- 532: Management of Insect-Pests and Diseases in Forestry 3(1+1)

Objective

To impart knowledge about maintaining plantations and forests under disease free conditions.

Theory

UNIT I

Classification of plant diseases, symptoms, signs, and related terminology. Parasitic causes of plant diseases (fungi, bacteria, viruses, phytoplasma, protozoa, algae and flowering parasitic plants), their characteristics and classification. Non-parasitic causes of plant diseases.

UNIT II

Importance of entomology in different fields. Definition, division and scope of entomology. Comparative account of external morphonology-types of mouth parts, antennae, legs, wings and genetalia. Structure, function of cuticle &moulting and body segmentation, Anatomy of digestive, Circulatory, Sensory, respiratory, glandular, excretory, nervous and reproductive systems. Types of reproduction.Important insects and pests of FOREST Nurseries and Forests/Plantations.

UNIT III

Principles and methods of integrated pests management – physical, cultural, chemical and biological methods. Use of attractants and repellants. Male sterility techniques.

UNIT IV

Diseases of forest nurseries and plantations. Abiotic agents of tree diseases and their relationship with hosts. Methods of disease control – exclusion, cultural, biological and chemical.

UNIT V

Rodents, Birds, squirrels, herbivores. Forest plant quarantine.

Practical

Familiarity with general plant pathological laboratory and field equipments. Study of disease symptoms and signs and host parasite relationship.Collection and identification of insects and non-insects. Inspection and collection of damaged material showing insect damage. Identification and use of plant protection equipments. Preparation of different concentrations of pesticides and Identification of important diseases in forest nurseries and plantations. Preparation of fungicidal concentrations and their use in controlling nursery and plantation.

Suggested Readings

Agrios, G.N. 2006. Plant Pathology. Elsevier Academic press, London.

Mehrotra, R.S. and A. Agarwal. Plant Pathology (2nd Edition) . Tata McGraw-Hill Publishing Company Limited, New Delhi. 846 p.

Evane JW. 1989. *Insect Pest and their Control*. Samir Book Center, Delhi.

Phillip DM. 1982. *Diseases of Forest and Ornamental Trees*. MacMilan.

Speight MR and Whylie F R. 2012. *Insect Pest in Tropical Forestry*. ACIAR

SAF 534: Crops and Animal Production Management in Agroforestry 3(2+1)

Objective

To impart knowledge on interactions between tree and live stock including their management, principles of crops and fodder production in Agroforestry

Theory

UNIT I

Choice of inter-crops for different tree species, sowing and planting techniques. Planting patterns, crop geometry, nutrient requirements, and weed management. Management of fodder tree species, thinning, lopping, pruning. Ecological and socio-economic interactions

UNIT II

Role of tree architecture and its management on system's productivity. Production potentials of fodder based agroforestry systems in different agro climatic conditions. Crop combination, crop combination interactions in crop mixtures. Importance of cattle –sheep and goat vis-à-vis agro-forestry systems. Feed and fodder resources in agro-forestry systems and live stock management.

UNIT III

Nutrient analysis of forages derived from fodder trees/shrubs. Nutrient requirement for various livestock and their ration computation with Agroforestry forages and tree leaves. Forage and tree leaves preservation.

UNIT IV

Calendars for forage crop production in agro-forestry systems including lopping schedules. Optimization of animal production. Animal products technology and marketing.

UNIT V

Integrated Agroforestry Farming System

Practical:

Measurement of crop growth rates. Study of tree crop association and management methods. Quantitative evaluation of tree-crop, livestock, Analysis of forages and feeds for mineral and incrementing constituents. Digestibility of some agro-forestry forages. Preparation of leaf meal and forage conservation. Familiarity with common veterinary instruments, AI equipments and common feeds and fodders and Field visits.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

SAF-535: Rangeland and Pasture Management 3(2+1)

Objective

Importance of rangeland, components of rangeland their characteristics and distribution, major types of rangeland in world and their characteristics, types of grasslands in India.

Theory

UNIT I

Concept of watershed management. Ideo-types of watershed development plans and activities for the watershed. Criterion for watershed size determination.

UNIT II

Principles and practices of range land management. Improvement of range productivity by vegetation manipulation through control of undesirable vegetation, burning, fertilization, soil and water conservation and protection. Range improvement and livestock management.

UNIT III

Feeding habits and grazing behavior of range livestock. Optimal livestock and range utilization, fodder from trees/shrubs and their nutritive values, propagation techniques, Micro climatic studies, root behavior, crown architecture including methods for minimizing unfavorable interactions.

UNIT IV

Production potential of different silvi-pasture systems, components of Silviculture. Pasture Management and its benefits, BMP (Best Management Practices) suitable species for Pastures for local and adjoining area of Rajasthan, Pasture rotation, Sustainable Pasture Management,

UNIT V

Characteristics of a watershed and their role in watershed management. Quantification of the benefits and effectiveness of the package of practices adopted for management of watershed, Dynamics vis-à-vis plant growth and post harvest processing for evaluation of chemical constituents.

UNIT VI

Biological and engineering approach in the management of degraded and denuded habitats as an integrated and multiple approach. SPP Testing. Provenance trials. Seed certification and storage. Elite trees selection. Range plant physiology –basic concepts, wood cycle and growth, carbohydrate reserves, determination of stocking - by forage production, livestock productivity and economic return. Effect of fire, grazing and fertilizes on plant growth. Range inventory and mapping, Types and their purpose, factors elaborated in a range inventory, grazing surveys, grazing capacity- its determination, range condition analysis.

Practical

Study of rangeland and pastures in and around the area. Identification of feedstuff and their nutritive value. Nutritive requirements of livestock. Study of hey and Silage.Cultivation practices of important fodder grasses and legumes of locality.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices*. Oxford and IBH, Dehradun.

Nair PKR, Rai MR and Buck LE. 2004. *New Vistas in Agroforestry*. Kluwer.The Netherlands

Nair PKR. 1993. *An Introduction to Agroforestry*. Kluwer, The Netherlands

Ong CK and Huxley PK. 1996. *Tree Crop Interactions – A Physiological Approach*. ICRAF, Nairobi.

Thampan PK. 1993. *Trees and Tree Farming*. Peekay Tree Crops Development Foundation.

Young A. 1997. *Agroforestry for Soil Management*. CABI, UK.

MINOR COURSES:

STAT-512: Statistical Methods and Computer Application 3(2+1)

Objective

To impart basic knowledge in the student about statistical methods and application of computers in their research field.

Theory

UNIT I

Need for statistics in forestry experimentation and planning – population and sample. Correlation and regression: correlation coefficient/coefficient of determination, simple regression analysis; examples of multiple regressions. Examples of linear regression and its fitting by least square method.

UNIT II

Normal distribution and its application in forestry - properties of normal distribution. Confidence limits. Expected value of mean and standard error.

UNIT III

Tests of significance - Test for means in one sample and two sample cases (Z and t tests). Z-test for proportion, Chi-square test of variance in one sample case. F-test of variance in two sample cases. Test of equality of K - means (one way and two way classification). Probability, basic laws of probability.

UNIT IV

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.

UNIT V

Need for sampling in forestry. Complete enumeration Vs partial enumeration. Principal steps in sample surveys, population, sampling unit, size of sample, (sample intensity) bias, accuracy and precision. Sampling variation and estimation of sampling error. Determination of sample *size* for a given level. Classified sampling design used in forest surveys. Simple random sampling - stratified random sampling. Systematic sampling - Point sampling.

UNIT VI

Basic principles of design of experiments, Uniformity trials and their uses, Fair field Smiths Variance Law and optimum size and shape of plots. Design and analysis of C*.R.D.* R.B.D. and L.S.D. with one observation per cell. Factorial experiments: Symmetrical and Asymmetrical factorial experiments, 2^n factorial experiments, Yates method and general method of analysis of AxB and AxBxC factorial experiments. Layout and analysis of Split and Strip plot design. Missing plot technique in R.B.D. and L.S.D. with one observation missing.

UNIT VII

Transformations: Square root, Logarithmic and Angular transformation.

UNIT VIII

Introduction to computer, MS Office, Statistical Application packages like MS-Excel, SPSS, R-software.

Practical

Laying out of designs in the field. Analysis of 2^2 and 2^3 experiments in R.B.D., Analysis of AxB factorial experiments. Analysis of AxBxC factorial 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. Analysis of results of the above design, Application of Statistical Packages like MS-Excel, SPSS, R-software with real forestry data.

Suggested readings

V.G. Panse and P.V. Sukhatme (1985). Statistical Methods for Agricultural Workers. ICAR, New Delhi.

S.C. Gupta and V.K. Kapoor (2014). Fundamentals of Mathematical Statistics. Sultan Chand and Sons, New Delhi.

Sukthame and C. Ashok (1984). Sampling Theories and Surveys with Application. ICAR, New Delhi, 3rd ed.

G.N. Rao (1983). Statistics for Agricultural Science. Oxford and IBH, New Delhi.

Das, M.N. and Giri. N.C. (1986). Design and analysis of Experiments. New Age International Publishers.

Kingra, H. S., Singh, G. (1993). Computer Basics for forestry, International Book Distributors, Dehradun.

Rajaraman, V and Adabala, N. (2015). *Fundamentals of Computers,* Pearson Education, New Delhi.

NRM- 511: Forest Soil and Land Reclamation 3(2+1)

Objective

To develop understanding and management skills of the students for forest soils and land reclamation practices

Theory

UNIT I

Introduction; Forest soil and its classification, soil forest types, Forest soils vs. cultivated soils. Genesis of forest soils, Properties of soils under different forest ecosystems.

UNIT II

Soil and tree planting, Amelioration of forest soils. Characterization of wasteland, present status and extent of non-arable lands and their productivity.

UNIT III

Salt affected soils, lateritic, marsh and swampy and rocky hills, rocky plains, murrammy and sandy soils, their characteristics and reclamation.

UNIT IV

Sites with superficial impervious hard pan. eroded ravines and gullies, various techniques of afforestation of adverse sites, trees suitable for adverse sites.

UNIT V

Afforestation and reclamation of mine wastes. Stabilization of tailing dumps and prevention of dust pollution. Sewage water as source of tree nutrients.

Practical

Exercise on sampling methods; Exercises on land use classes; Exercises on light-spectral characteristics; Analysis of soil for Gypsum and lime requirement; Exercises on study of eroded soils; Study on types of pits and trenches, tree species suitable for mined out areas; Visit to nearest mined areas. Drainage and reclamation of water logged lands; Measurement of irrigation water by various method; Design of graded bunds; Design and layout of waterways; Survey design and layout of bench terraces; Design and layout of diversion channels; Study of different water harvesting structures; Land leveling and its cost estimation; Study of drip irrigation system; Study of sprinkler irrigation system; Study of pumping system; Economic analysis of wasteland development.

Suggested Readings

R.K.Luna 1996 *Plantation Forestry*
Wilde, S.A. 1994 *Forest soil and Forest growth*
Dewedi, A.P. 2002 *A Textbook of Silviculture*

NRM- 512: Land use and Watershed Management 3(2+1)

Theory

UNIT I

Soli and Land, Land use patterns in India and Rajasthan, Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency. Biota- vegetation types, distribution and utilization.

UNIT II

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity issues. Formulation of watershed projects (micro and macro watershed).

UNIT III

Components of natural resources for watershed management. Preparation techniques for micro plan of watershed. Impact assessment techniques for upliftment of socio-economic status and environment. Valuing Inputs and Outputs.

UNIT IV

Watershed survey, mapping and structural engineering designs-Compass, Surveying, Plane table surveying, Leveling, Preparation of contour maps of watershed. Terraces and bunds- types & design.

UNIT V

Soil and water conservation and water harvesting structures – types & design. Sedimentation- sources, estimation of sediment bank treatment techniques. Hydrological cycle and characteristics of small and medium watersheds precipitation, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water and evapo-transpiration. Resources inventory soil, land, water and Biota.

UNIT VI

People participation and impact analysis in watershed management- Community organizations – Definition, Principles advantages, Community mobilization. Psychodynamics of group processes decision making, leadership, and conflict management and group strategies. Participatory planning, implementation, monitoring and evaluation. Participatory research approaches. Socio economic impact analysis, financial analysis.

Practical:

Survey of watershed, Preparation of micro-plan and planning of watershed for effective implementation. Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Study of flood control reservoirs; Exercises on economic profitability of various land-based enterprises bases in cost and revenue concepts. Preparation of contour maps, Estimation of earth work, Design of check dams, Acquaintance with water lifting devices, Use of measurement, Conveyance and control structures.

Suggested readings

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.

Murty, J.V.S. 1995. *Watershed Management in India.* Wiley Eastern, New Delhi.

Oswal MC. 1999. *Watershed Management* (For Dryland Agriculture),Associated Pubg Co., Delhi.

Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.

5.Dhuruva Narayana, V.V., Sastry, G. and Patnaik, V.S. 1990. *Watershed Management.* ICAR Publication, New Delhi.

NRM-531: Remote Sensing and Geographic Information System 3 (2+1)

Objective

Importance Remote sensing, components of Digital image processing, image analysis and classification, Use of GIS and GPS. Use of GIS software in Forestry.

Theory

UNIT I

Orientation to subject- use History and use of aerial photography, Satellite imagery and geographic information system

UNIT II

GIS for the collection, storage and spatial analysis for geo-referenced forest resources data and information.

UNIT III

The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management

UNIT IV

Satellite systems; satellite imageries – techniques, uses and limitation, Future prospects of remote sensing in India

UNIT V

Software used in remote sensing ; GIS versus remote sensing; GIS Software used in forestry and environments, Analysis of data; Application of GIS in forestry

Practical

Uses of various photogrammetry instruments, Recognition and identification of objects on photography, Compilation of maps and their interpretation, Hands on practice on remote sensing software, Hands on practice on GIS software

Suggested Readings :

Burrough P.A.1990. *Principles of GIS for Land Resources Assessment*. Oxford and IBH.

Lillsand T. M.1989. Remote Sensing and Image Interpretation. John Wiley.

Narayanan L.R.A. 1999. Remote Sensing and its application. University Press(India)/Orient Longman.

Sharma, N. K. 1986. Remote Sensing and Forest Survey. IBD, Dehradun.

SAF-511: Forests and Climate Change 3 (2+1)

Objective

Importance of forests and vegetation in the present era of climate change.

Theory

UNIT I

Weather and Climate, Climatic zones of India. Evaporation and transpirationcomponents of atmosphere, hydrosphere, pedosphere, biosphere and their interactions. Ecosystems of the world, Climate and its impact on agriculture, agro-climatic regions, soils and cropping patterns of India and agriculture productivity.

UNIT II

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest

UNIT III

Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on forests and agro-forestry- Climate resilient forestry.

UNIT IV

Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change.

UNIT V

National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere. Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer.

Suggested Readings

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and ForestGenetic Diversity: Implications for Sustainable Forest Managementin Europe*. Biodiversity International, Rome, Italy.

Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and ForestGenetic Diversity: Implications for Sustainable Forest Managementin Europe*. Biodiversity International, Rome, Italy.

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Lenka,D. (1997) Climate, weather and crop in India. Kalyani Publishers, New Delhi

Mavi, H.S. (1994) Agrometerology . Oxford &IBH, New Delhi

Rao, GSLHVP (2003) Agrometeorology, KAU, Thrissur, Kerala,

Seemann, J., Chirkov, Y.I., Lomas, J., and Primault, B. (2012) Agrometeorology. Springer Berlin Heidelberg

Varshney, M.C. and Pillai, P.B. (2003) Textbook of Agrometeorology. ICAR , New Delhi.

SAF- 533: Forest Policy, Laws and International Conventions 3(2+1)

Objective

To develop understanding of students about forest policy and laws and international conventions

Theory

UNIT I

Forest policy – Relevance and scope; National Forest Policy – 1894, 1952 and 1988; Environment policy 2006, Agriculture policy, Policy on abetment of Pollution, National Eco tourism Policy ,National Tourism Policy, National Trade Policy, National Water Policy etc. Land Use Policy, Industrial Policy, Policy on resettlement and rehabilitation .

UNIT II

General principles of criminal law; Indian Penel Code, criminal procedure code; Indian evidence act applied to forestry matters.

UNIT III

Forest laws; Indian Forest Act –1927, general provision and detailed study; Forest Conservation Act 1980, Important Forest Rules and Guidelines. Wildlife Protect Act 1972, Biodiversity act 2002, Biodiversity Rules 2004, Plant Varieties Protection and Farmer's Rights Act 2001, Geographical Indications of Goods Act 1999. The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006, Water (Preventing and Control of Pollution) Act 1974; Air (Prevention and Control of Pollution) Act 1981; Environment (Protection) Act 1986, etc.

UNIT IV

International conventions- Convention on Biological Diversity 1992 (CBD) Cartagena Protocol on Bio-Safety 2000 (CPB), United Nation Framework Convention on ClimateChange, Kyoto Protocol, WTO and Environment, TRIP and Patenting Issues. Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES),

UNIT V

Ramsar Convention on Wet Lands, The Basel Convention on the Control of Trans-boundary Movement of Hazardous Wastes and their Disposal , The Montreal Protocol , IPCC, ICCD, etc. Important forestry institutions, case studies and landmark judgments.

Practical

Study of procedure for seizure of property. Visit to forest department and courts to observe penalty procedures. Preparation of first information report and enactment report. Study of working plans of the forests and to prepare the working plan for one of the area in the range.

Suggested Readings

Indian Forest Acts (with short notes)1975. Allahabad Law Agency.

Jha LK. 1994. *Analysis and Appraisal of India's Forest Policy.* Ashish Publ. House.

National Forest Policy 1952. Ministry of Food and Agriculture, New Delhi.

National Forest Policy 1988. Ministry of Environment and Forests, New Delhi.

Negi SS. 1985. *Forest Law*. Natraj Publ.

Saharia VB. 1989. *Wildlife Law in India*. Natraj Publ.

SAF- 512: Ecotourism and Participatory Forestry 3(2+1)

Theory

UNIT I

Eco tourism - study history of tourism- identify various forms of tourism and evolution of ecotourism. Mass tourism versus ecotourism. Organized tours and Free Independent Travelers.

UNIT II

World Tourism Organization. Problems with definition of ecotourism and criticisms. Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Different forms of ecotourism like hard and soft ecotourism.

UNIT III

Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism. Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context. Planning ecotourism in protected areas. - Visitor management in ecotourism areas - zoning, carrying capacity.

UNIT IV

Participation of local people in ecotourism.,PRA and RRA, Ecotourism for sustainable development of PA's. New directions in ecotourism industry. Ecotourism in practice in important PA's of India - case studies Limitations and problems of ecotourism.

UNIT V

Ecotourism as a way for sustainable management of natural resources. Local livelihoods and eco-tourism like nomadic grazing, agro- pasturatism).Desiging and landscaping in ecotourism. Design and management of ecotourism. Economics of ecotourism. Modern Research approaches on Eco-tourism.

Practical

Students should make detailed reference on the various forms of Ecotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism. Problems on common property resources and facilitate group discussion for recommendations. Evaluation and monitoring of the various ecotourism activities of the region such as Nature Walk - The guided day trek, The Tiger Trail, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage, Jungle Inn, The Sacred groves, Bamboo Grove, Green Mansions, the backwater cruise. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area, evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*.Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

SAF- 536: Production Management in Nursery and Plantation Forestry 3(2+1)

Objective

To develop understanding and management skills of the students in respect of commercial nursery production and plantation forestry.

Theory

UNIT I

Introduction to production theory. Production concepts, Resource-Product Relationship, Types and Kinds of Production Functions, Principles of choice and resource allocation in nursery production, Resource combination and cost minimization, Resource allocation and enterprise combination. Technical and economic efficiency, Derivation of cost and supply functions from production functions, break-even analysis managing risk and uncertainty in nursery and plantation forestry.

UNIT II

Planning and budgeting techniques applied in nursery production and plantation forestry. Record book keeping system. Income and cash flow analysis.

UNIT III

Time value of money, Principles of financial analysis, Investment analysis in plantation forestry, Determination of optimum rotation period.

UNIT IV

Market structure, Functions, Channels, Marketing efficiency and marketing problems of nursery and plantation forestry.

Practical

Exercises on marginal analysis in nursery production, Exercises on time-value of money and investment analysis. Exercises on marketing channels, costs, margin and price spread for different nursery and plantation crops.

Suggested Readings

Bamoul WJ & Oates WE. 1975. *The Theory of Environmental Policy*.Prentice Hall.

Busby RJN. 1981. *Investment Appraisal in Forestry*. Forestry Commision Research Station, Surveys.

FAO 1986. *Guidelines to Project Evaluation*. Natraj Publ.

FAO. 1981. Tropical Forest Resources Assessment Project (In the Framework of Gems). *Forest Resources of Tropical Africa*. Part I & II. *Regional Synthesis*.

Kerr JM, Marothia DK, Singh K, Ramaswamy C & Bentley WR. 1997.

Natural Resource Economis – Theory and Application in India. Oxford & IBH. Dehradun

Makchau JP & Malcolm LR. 1986. *Economics of Tropical Farm Management.* Cambridge Univ. Press.

Nautiyal JC. 1988.*Forest Economics - Principles and Applications*. Natraj Publ.dehradun

Sharma LC. 1980.*Forest Economics – Principles and Applications*. Natraj Publ.

Upton M. 1976. *Agricultural Production and Resource Use*. OxfordUniv. Press

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

Objective

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

Practical

Technical Writing

Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, 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 article.

Communication Skills

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

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins, London

Gordon HM and Walter JA. 1970. *Technical Writing.* 3rd Ed. Holt, Rinehart and Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English.* 6th Ed. Oxford University Press, Oxford

James HS. 1994. *Handbook for Technical Writing.* NTC Business Books.

Joseph G. 2000. *MLA Handbook for Writers of Research Papers.* 5th Ed. Affiliated East-West Press.

Mohan K. 2005. *Speaking English Effectively.* MacMillan India.

Richard WS. 1969. *Technical Writing.* Barnes & Noble.

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language.* Abhishek. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English.* 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition.* S. Chand & Co. New Delhi.

PGS-503: e course-Intellectual Property and its Management in Agriculture (1+0)

Objective

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

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology.* CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy.* McGraw-Hill, New Delhi.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

Ministry of Agriculture, Government of !ndia. 2004. *State of Indian Farmer.* Vol. V. *Technology Generation and IPR Issues.* Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics.* CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies.* Daya Publ. House, New Delhi.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS-506: Disaster Management 1 (1+0)

Objectives

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Gupta HK. 2003. *Disaster Management.* Indian National Science Academy. Orient Blackswan.

Hodgkinson PE and Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management.* Routledge, London.

Sharma VK. 2001. *Disaster Management.* National Centre for Disaster Management, India.

FORT-451: Practices of Silviculture 3 (2+1)

Objective

To acquaint the students about general practices of silviculture in India and Rajasthan with examples of important trees.

Theory

UNIT I

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT II

Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration.

UNIT III

Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

UNIT IV

Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration- accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

UNIT V

Tree planting- Sowing v/s planting different kinds of pits. Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

UNIT VI

Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations, -objectives and uses

Practical

Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices.* Oxford and IBH, New Delhi.

Khanna LS. 1996. *Principle and Practice of Silviculture.* International Book Distributors, Dehradun.

Dwivedi AP. 1993. *A Text Book of Silviculture.* International Book Distributors, Dehradun

Khanna L. 1996. *Principles and Practices of Silviculture.* International Book Distributors, Dehradun

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-applied Forest Ecology.* John Wiley and Sons, New York.

FORT-452: Forest Products and Utilization 3 (2+1)

Objective

To acquaint the students about various forest products, availability of raw material and best utilization practices in India.

Theory

UNIT I

Introduction, methods of collection, management and importance of Non-Wood Forest Products (NWFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non Essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees.

UNIT II

Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits and vegetables, spices, poisons and bio-pesticides. Honey, Lac, and silk- their importance, extent and processing.

UNIT III

Pulp and paper industry. Introduction and raw material; pulpingmechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT IV

Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board.

UNIT V

Adhesives used in manufacture of composite wood. Improved wood , definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood. Production of wood molasses, alcohol and yeast.

Practical

Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

Suggested Readings

Anonymous. 1981. *Wealth of India.* CSIR Publ., New Delhi.

Anonymous. 2007. *Year Book of Forest Products.* FAO.

Dwivedi AP. 1993. *Forestry in India.* Surya Publ., New Delhi.

FORT-453: Dendrology and Forest Botany 3 (2+1)

Objective

To acquaint the students about various forest plants and trees, their identification and systematic.

Theory

UNIT I

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems.Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature.

UNIT II

Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc.

UNIT III

Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts.

UNIT IV

Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system.

UNIT V

Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Santalaceae, Papilionaceae, Caesalpiniaceae Mimosaceae, Elaeagnaceae, Meliaceae, Salicaceae, Rutaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Asteraceae, Moraceae, Poaceae, Tiliaceae, Euphorbiaceae, Myrtaceae and Combretaceae, Liliaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae,.

UNIT VI

Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. Study of woody flora of: Magnoliaceae, Ebenaceae and Tiliaceae; Papilionaceae, Caesalpiniaceae and Mimosaceae;; Moraceae and Poaceae; Meliaceae, and Salicaceae; Apocynaceae; Combretaceae, Myrtaceae and Santaleceae; Asteraceae, Sapotaceae and Verbenaceae; Euphorbiaceae and Liliaceae.

Suggested Readings:

Bhandari, M.M. (1978). Flora of Indian Desert, Scientific Pub., Jhodhpur, Pp. 471.

Bor, N.L. (1996) Manual of Indian Forest Botany, IBD Pub., Dehradun, Pp. 441.

Brandis, D. (1874). The Forest Flora of North-west and Central India (Repr. Ed. 1972). Bishen Singh & Mahendra Pal Singh, Dehradun, India.

Dasgupta, S. (1988). Systematic Botany for Foresters, Khanna Bandhu Pub., Dehradun, Pp. 210.

Harlow, William M., Editor (1995). Textbook of Dendrology, Authors, Ellwood S. Harrar, James W. Hardin, Fred M. White), McGraw-Hill Companies, Pp. 534.

Krishen, Pradeep (2006). Trees of Delhi-A Field Guide, DK Pub., India, Pvt. Ltd. New Delhi, Pp.360.

Kumar, Ashok (2001). Botany in Forestry and Environment, Kumar Media Pvt. Ltd., Dehradun, Pp. 716.

Naik V. N. (2003). Taxonomy of Angiosperms,

Pandey, B.P. (1978). Economic Botany, S Chand Pub., Pp.534.

Sharma, N. (2002). The Flora of Rajasthan, Avishkar Pub Distributors, Jaipur, Pp.208.

Singh, V. and D.K. Jain (2006). Taxonomy of Angiosperm**.**

SYLLABUS

For

M.Sc. Forestry (Wildlife Sciences)

2018-19

FACULTY OF FORESTRY

DEPARTMENT OF WILDLIFE SCIENCES

COLLEGE OF HORTICULTURE AND FORESTRY,
JHALARAPATAN, JHALAWAR
(AGRICULTURE UNIVERSITY, KOTA)

M.Sc. Forestry (Wildlife Sciences)
Semester-wise Distribution of Courses

	Semester I	
Course Number	**Course Title**	**Credit**
FORT- 511	Silviculture and Forest Biometry	3 (2+1)
FORT- 512	Forest Management and Protection	3 (2+1)
FORT- 513	Tree Physiology and Tree Improvement	3 (2+1)
STAT- 512	Statistical Methods and Computer Application	3 (2+1)
SAF - 511	*Forest and Climate Change	3 (2+1)
SAF-512	*Ecotourism and Participatory Forestry	3 (2+1)
WLS-511	*Captive Animal and Biological Parks Management	3 (2+1)
NRM-512	*Landuse and Watershed Management	3 (2+1)
	Any one to be opted	
	Total Credit Hours of Courses	**15(10+5)**
FORT-451 Deficiency Course	Practices of Silviculture	3 (2+1) NC
	Semester II	
Course Number	**Course Title**	**Credit**
WLS-521	Taxonomy and Biology of Wild Animals	3 (2+1)
WLS-522	Wildlife Ecology and Conservation Biology	3 (2+1)
WLS-523	Wildlife Population Dynamics	3 (2+1)
WLS-524	Ethology of Wild Animals	3 (2+1)
	Total Credit Hours of Courses	**12(8+4)**
PGS-502	e-course Technical Writing and Communication Skills	1 (0+1) NC
FORT-452 Deficiency Course	Forest Products and Utilization	3 (2+1) NC
	Semester-III	
Course Number	**Course Title**	**Credit**
FORT-531	Forest Products –Chemistry and Industries	3(2+1)
WLS-531	**Wildlife Nutrition, Disease and Health Management	3(2+1)
WLS-532	**Wildlife Crime, Legislation and Forensic Sciences	3(2+1)
WLS-533	**Endangered Species Management	3(2+1)
WLS-534	*Wildlife Photography, Nature Interpretation and Education	3(2+1)
WLS-535	*Man and Animal Conflict	3(2+1)
NRM-531	*Remote Sensing and Geographic Information System	3(2+1)
WLS-591	Credit Seminar	1(0+1)
	Any one to be opted **Any one to be opted	
	Total Credit Hours of Courses	**10(6+4)**
PGS -503	e-course -Intellectual property and its Management in Agriculture	1 (1+0) NC
PGS -506	e-course-Disaster Management	1 (1+0) NC
FORT-453 Deficiency Course	Dendrology and Forest Botany	3 (2+1) NC
	Semester-IV	
Course Number	**Course Title**	**Credit**
WLS-541	Comprehensive (NC)	1 (1+0) NC
WLS -599	Research	20(0+20)
	Total Credit Hours (I+II+III-IV) (15+12+10+20)	**57**

Any one to be opted, ** Opt one from either course (only for wildlife sciences students)

MASTER OF SCIENCE FORESTRY (WILDLIFE SCIENCES) COURSES APPROVED BY THE ADVISORY COMMITTEE

CORE courses	FORT- 511	Silviculture and Forest Biometry	3 (2+1)
	FORT- 512	Forest Management and Protection	3 (2+1)
	FORT- 513	Tree Physiology and Tree Improvement	3 (2+1)
	FORT- 531	Forest Products –Chemistry and Industries	3 (2+1)
		Total (Core Courses)	**12(8+4)**
MAJOR courses	WLS-521	Taxonomy and Biology of Wild Animals	3 (2+1)
	WLS-522	Wildlife Ecology and Conservation Biology	3 (2+1)
	WLS-523	Wildlife Population Dynamics	3 (2+1)
	WLS-524	Ethology of Wild Animals	3 (2+1)
	WLS-531	**Wildlife Nutrition, Disease and Health Management	3 (2+1)
	WLS -532	**Wildlife Crime, Legislation and Forensic Sciences	3 (2+1)
	WLS -533	**Endangered Species Management	3 (2+1)
		***Any one to be opted (as per semester distribution option)*	
		Total (Major Courses)	**15 (10+5)**
MINOR courses	STAT-512	Statistical Methods and Computer Application	3 (2+1)
	SAF-511	*Forest and Climate Change	3 (2+1)
	SAF-512	*Ecotourism and Participatory Forestry	3 (2+1)
	WLS-511	*Captive Animal and Biological Parks Management	3 (2+1)
	WLS-534	*Wildlife Photography, Nature Interpretation and Education	3 (2+1)
	WLS-535	*Man and Animal Conflict	3 (2+1)
	NRM-512	*Landuse and Watershed Management	3 (2+1)
	NRM-531	*Remote Sensing and Geographic Information System	3 (2+1)
		** Any Two to be opted(as per semester distribution option)*	
		Total (Minor Courses)	**9(6+3)**
NON - CREDIT	PGS 502	e-course Technical Writing and Communication Skills	1(0+1) NC
	PGS 503	e-course -Intellectual property and its Management in Agriculture	1(0+1) NC
	PGS 506	e-course -Disaster Management	1(1+0) NC
***NON - CREDIT Deficiency	FORT-451	Practices of Silviculture	
	FORT-452	Forest Products and Utilization	
	FORT-453	Dendrology and Forest Botany	
		***Required to be offered by the students not having B.Sc. Forestry Degree Programme**	
	WLS-591	Credit Seminar	**1(0+1)**
	WLS-541	Comprehensive (NC)	1(1+0) NC
	WLS-599	Research	**20(0+20)**
		Grand Total	**57**

Core Courses

FORT-511 Silviculture and Forest Biometry 3 (2+1)

Objective

To provide knowledge about Forest ecosystem concept, stand dynamics-forest succession, productivity and vegetation forms and natural regeneration of tree species. To develop understanding of students about tree measurements, forest inventory and yield concepts

Theory

UNIT I

Forest ecosystem concept, stand dynamics-forest succession, competition and tolerance, classification of world's forest vegetation.

UNIT II

Productivity and vegetation forms of India, forest composition and structure. Ecophysiology of tree growth, effect of radiation & water relationship, mineral nutrients and temperature.

UNIT III

Natural regeneration of species and types including uneven aged silviculture. Intermediate treatments.

UNIT IV

Measurement of tree parameters. Estimation of volume, growth and yield of individual tree and forest stands, Preparation of volume & its application, yield and stand tables.

UNIT V

Forest inventory, Sampling methods adopted in forestry, Use of GPS in forest inventory. Measurement stand density. Simulation techniques.

UNIT VI

Growth and yield prediction models – their preparation and applications.

Practical

Calculations of volume of felled as well as standing trees., Volume table preparation., Application of sampling procedures., Handling of GPS., preparation of yield and stand table.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practice*s. Oxford and IBH.

Dwivedi AP. 1993. *A Text Book of Silvicultur*e. International Book Distributors, Dehradun.

Khanna LS. 1996. *Principle and Practice of Silvicultur*e. International Book Distributors.

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

Chaturvedi AN & Khanna LS. 1994. *Forest Mensuratio*n. International Book Distributor.

Ram Parkash 1983. *Forest Surveyin*g. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. *Introduction to Forestr*y. McGraw-Hill.

Simmons CE. 1980. *A Manual of Forest Mensuratio*n. Bishen Singh Mahender Pal Singh, Dehradun

FORT-512 Forest Management and Protection 3 (2+1)

Objective

To provide knowledge about forest management, ecosystem management, site quality evaluation, stand density and forest valuation. To provide knowledge to students about forest protection through diseases and pest management.

Theory

UNIT I

Principles of forest management; scope and object of forest management, ecosystem management, development of forest management in India.

UNIT II

Site quality evaluation and importance. Stand density, classical approaches to yield regulation in forest management, salient features and strategies. Forest valuation and appraisal in regulated forests.

UNIT III

Important diseases and insect pests of nurseries, farm forestry, plantations, avenue trees and their management. Assessment of losses due to diseases, insect pests, vertebrate pests, adverse weather, forest fires and weeds. Insect pests and mycoflora of seeds of forest trees and their management.

UNIT IV

Biodegradation of wood – microscopic and chemical effects of white rot, brown rot, soft rot and wood discoloration. Heart rots – factors affecting heart rots, damage caused, compartmentalization of decay in trees and management of heart rots. Role of mycorrhiza in tree health.

UNIT V

Theories of natural regulation of insect populations. Wildlife damage in nurseries, plantations and their management. Weed problems in nurseries, plantations and their control. Adverse climatic factors, acid rains and air pollutants in relation to forest tree health.

UNIT VI

Biological control of insect pests and diseases of forest trees. Molecular tools for developing disease resistance trees.

Practical

Study forest organizational set up and forest range administration including booking of offences. Visit to forest plantation- Field Exercise for the estimation of actual growing stock volume. Collection, identification and preservation of important insect pests and disease specimens of forest plants. Assessment of losses due to diseases, insect pests etc.. Laboratory tests for estimating decay resistance in wood. Fire control methods and devices, Familiarization with the meteorological and plant protection equipment, Application of pesticides and bio-control agents in the management of insect pests, weeds, diseases in nurseries and plantations, Extraction of spores of arbuscular mycorrhizal (AM) fungi from soil and assessment of mycorrhizal root infection.

Suggested Readings

Ajay S Rawat. *History of Forest in India*
Avery and Burkhart. *Forest Measurement*
Brasnet, NV. *Planned Management of Forests*.
Duerra Telquarden. *Forest Resource Management*
Lawrance S. Davis and K.Morman Johson. *Forest Management*
Maslekar. *Managing the forest*
Myth D Realty by J B Lal. *India's Forests*
Oliver, CD and Larson BC. *Forest Stand Dynamics*
Osmaston. *Management of Forest*
Ram Parkash. *Forest Management,*
Sharma, LC. *Forest Economics, Planning and Management*
Bakshi BK. 1976. *Forest Pathology*. Controller of Publications, GOI.Jha LK and Sen Sarna PK. 1994. *Forest Entomology*. Ashish Publ. House.
Manion PD. 1991. *Tree Diseases Concept*. Prentice Hall.
Stebbings EP. 1977. *Indian Forest Insects*. JK Jain Bros.

FORT-513 Tree Physiology and Tree Improvement 3(2+1)

Objective

To acquaint the students about general principles tree physiology tree breeding with examples of important trees.

Theory

UNIT I

Introduction to tree physiology. Plant-water relations, Concept of water potential, ascent of sap and water balance. Stomatal physiology - stomatal conductance – resistance. Mineral nutrition - macro-micro nutrients - Arnon's criteria of essentiality – deficiency.

UNIT II

Plant growth regulators – classification. Tree structure, Growth and development - growth kinetics. Growth regulation and co-ordination - Plant growth analysis -Canopy architecture. Water relations of forest trees – Transpiration from forest canopies - Water use efficiency of forest stands. GPP and NPP of forest stands -Carbon cycling - Nutrient dynamics and plant growth – Nutrient cycling of C, N, P, S.

UNIT III

General concept of forest tree breeding, tree improvement and forest genetics.

UNIT IV

Reproduction in forest trees, dimorphism pollination mechanism. Pollen dispersal, pollinators. Attractants for pollinators.

UNIT V

Variation in trees, importance and its causes. Natural variations as a basis for tree improvement. Geographic variations – Ecotypes, clines, races and land races.

UNIT VI

Seed, seed formation, dispersal, storage and seed dormancy.

UNIT VII

Selective breeding methods- mass, family, within family, plus within family. Plus, tree selection for wood quality,

UNIT VIII

Progeny and clone testing. Seed orchards – type, functions and importance. Estimating genetic parameters and genetic gain.

UNIT IX

Heterosis breeding: inbreeding and hybrid vigour. Manifestation and fixation of heterosis. Species and racial hybridization. Indian examples – teak, sal, shisham, eucalypts, Neem,etc.

UNIT X

Polyploidy, aneuploidy and haploidy in soft and hard wood species. Induction of polyploidy.

UNIT XI

Biotechnology in tree improvement.

Practical:

Estimation of stomatal index. Estimation of water potential in plants using Estimation of leaf area of plants. Plant growth analysis – RGR, NAR, and LAR - specific leaf area and leaf weight ratio - LAI - CGR – LAD etc. Measurement of relative water content, leaf water potential, osmotic potential Observation on tree architecture of important species Study of Floral biology of important trees in the region, Estimating pollen viability. Controlled pollination and pollen handling. Manipulation of flowering through hormones. Visit to species, provenance and progeny trials. Selection of superior phenotypes. Marking of candidate trees, plus trees and elite trees. Visit to seed orchards. Comparison of parents and their putative hybrids.

Suggested Readings

Hopkins, W.G. and Huner, N.P.A. (2008) *Introduction to plant physiology*. Wiley.

Kramer, P.J. and Kozlowski, T.T. (1979). Physiology of Woody Plants. John Wiley and sons. New York

Landsberg, J.J (1986). Physiological Ecology of Forest Production. Academic Press Inc., London

Landsberg, J.J and Gower, S.T (1997). Applications of Physiological Ecology to Forest Managment. Academic Press Inc., London.

Salisbury, F. B. and Ross,C. W. (2004) . Plant Physiology. Thomson Asia Ptd, Ltd. Singapore.

Mandal AK and Gibson GL. (Eds). 1997. *Forest Genetics and Tree Breeding*. CBS.

Surendran C, Sehgal RN and Paramathma M. 2003. *Text Book of Forest Tree Breeding*. ICAR Publ.

Wright JW. 1976. *Introduction to Forest Genetics*. Academic Press.

White TL, Adams WT and Neale DB. 2007. *Forest Genetics*. CABI, UK.

Zobel BJ and Talbert J. 1984. *Applied Forest Tree Improvement*. John Wiley and Sons.

FORT-531 Forest Products –Chemistry and Industries 3(2+1)

Objective

The course will equip the students regarding wood-based industries. How it is affecting the economy of the country such as match and splint, sports and pencil making, besides this wood extracts resins and gums, katha, tannins and various types of non-timber products. Practical will make them aware regarding extraction method of different products of wood.

Theory

UNIT I

Importance of forest-based industries in relation to Indian economy. Chemistry in relation to forest products

UNIT II

Description of different forest-based industries - paper and pulp, furniture, bamboo, sports goods, pencil making, match box and splint making, use of woods of lesser known forest species for commercial purposes.

UNIT III

Cell wall constituents. Chemistry of cellulose, starch, hemicelluloses and lignin. Extraneous components of wood - water and organic solvent soluble. Chemical composition of oleoresin from major pine species. Structural difference among different gums (arabic, ghatti, tragacanth).

UNIT V

Chemical nature and uses of volatile oils, tannins, katha and cutch. Chemical nature and uses of important forest-based dyes and pigments.

Practical

Estimation of cell wall contents - Hemicellulose and lignin, Extraction of essential oils, resins, tannins, Acetylation of wood. Visit to nearby forest-based industries.

Suggested Readings

Principles of Eood Science and Technology (Solid wood) Vol. I & II by FP Kollmann and Wilfred A. Cote Jr.
Indian Forest Utilization, Vol. I FRI Dehradun Publication.
Text Book of Wood Technology by A.J. Panshin and Carlde Zeeuw.
An Introduction to Plant Anatomy by Arthur J. Eames and Lausence H. McDaniel.
Indian Forest Utilization Vol. I FRI Dehradun, Publication.
A key of Identification of Fifty Important Timbers of India, FRI, Dehradun.
Anatomy of Wood- its Diversity and Variability by Wilson K and D.J.B. White.
The chemistry of solid wood by Roger Rowell.
Principles of wood Science & Technology-I Solid Wood by Kollmann FP & Widfred A. Cote Jr.
The chemistry of Natural Products (Vol.-II): The Natural Pigments by K.W. Bentley.
The chemistry of plant gums and mucilages by F. Smith and R. Montyomery.
Wood chemistry: Fundamentals and applications by E.S. Jostrom.
Methods of wood chemistry (Vol. I and II) by B.L. Browning organic chemistry by R.T. Morisson and R.N. Boyd.

Major Courses

Objective

The course will equip the students regarding the basis of taxonomy like classification, nomenclature, its time of evolution and characteristics.

Theory

UNIT I

Taxonomy, ~~History~~, Binomial nomenclature, Role of organization, Modern classification, Phylogenetic relationship, Vertebrates and Invertebrates. Characters to identify Class-Sub class -Order-Super Order and Family with examples; Class Pisces -Reptiles-Amphibians -Aves -Mammals;

UNIT II

Class Pisces -Salient features, Nutrition, Respiration, Locomotion (Fish migration, adaptations) Reproduction, Spawning-Fish eggs, larvae, Limnology, Pisces culture, Age determination; Diversity of Fishes, economically important Fishes -India; Marking-tagging, Availability of exotic fishes and its impact.

UNIT III

Class Amphibia-Evolution-Salient features; Order-Anura-Urodella-Apoda-Nutrition-Respiration- Locomotion -Reproduction ; Distribution-Indian Amphibians -Endangered Amphibians ; Class Reptilia-Evolution-Salient features ; Sub class-Anapsida -Parapsida -Diapsida-Synapsida ; Nutrition-Respiration-Locomotion -Reproduction-Distribution -Distinctive features-Indian Turtle --Tortoise -Terrapins-Indian lizards -Sphenodon-Indian Snakes-Crocodiles; Class Aves -Evolution-Salient features -Flight adaptation and Migration.

UNIT IV

Class Mammalia -Origin-evolution-adaptive radiation ~~distinctive characters~~ Digestion-herbivores-carnivores and Ruminant -Circulation -Excretion -Respiration; Breeding Biology-Feeding ecology-Oestrus cycle-Elephants -Rhino -Primates-Bats -Felids; ~~Placental dichotomy~~, Diversity-marsupials; lnsectivorous mammals; Endemic-Endangered-Extinct mammals-India-Economic value.

Practical

Animal Classification; Identification-Annelida-Arthropoda-Mollusca-Echinodermata; Identification-Fishes, Amphibians, Reptiles, Indian Snakes, Handling of Reptiles; Identification of birds: Spoonbill Sandpiper, Lesser Flemingo, Greater Flemingo, Bar headed goose, Grey Pelican, Great Pied Hornbill, Ceylon Frogmouth, Nilgiri Laughing Thresh, Nilgiri Flycatcher ; Identification-Mammals Skulls-Teeth of mammals-determination of dental formulae-Age-Sex determination; Preservation and Taxidermy-Visit to Museum and Institutes.

Distribution-Identifying features-Life expectancy-Echidna-Platypus -Bats -Lemur-Loris -Rats -Squirrels Hare ; Dolphins -whales ; Wild dog-wolf-foxes ; Otter-Bear ; Panthera -Felis -Civet -Mongoose ; Hyena -Ant eaters ; Monkeys-Langurs -Apes-Gibbons-Baboons ; Deers-Antelopes -Thar -Gaur; Elephants -Rhinoceros -Hippopotamus -Wild Ass --Snakes -Crocodiles-Turtles-Tortoise.

Suggested Readings

Prater SH, 1988. *The Book of Indian Animals*. BNHS, Bombay.

David MacDonald, 1984. *Encyclopaedia of Mammals,* Vol. I & II. George Allend and Unwin, London.

EkambaranathaAyyar M. and Ananthakrishnan TS, 1982. *A manual of zoology* (Vol I, Part I) Invertebrata; S. Vishwanathan (Printers and Publishers), PVT, LTD.

EkambaranathaAyyar M. and Ananthakrishnan TS, 1982. *A manual of zoology* (Vol I, Part II) Invertebrata; S. Vishwanathan (Printers and Publishers), PVT, LTD.

EkambaranathaAyyar M. and Ananthakrishnan TS, 1982. *A manual of zoology* (Part II) Chordata; S. Vishwanathan (Printers and Publishers), PVT, LTD.

WLS-522 Wildlife Ecology and Conservation Biology 3(2+1)

Objective

The course will equip the students regarding different level of organization, about species and its relationship with the surrounding environment and with other organisms.

Theory:

Sympatric species, resource partitioning. Group living: costs, benefits and optimal group size. Selfishness and altruism. Evolutionarily stable strategies; predator prey relationships and evolutionary arms race. Competition for resources: ideal free distributions and resource defence. Concept of optimality in decision making in animals; optimal foraging theory and other models. Testing hypotheses in behavioral ecology: Comparative methods, experimental studies, individual decisions in ecology. Sexual selection; parental care. Cooperation and helping in mammals, birds and fishes. Ecology and evolution of signals and communication pathways. Free ranging population and Captive population.

Biodiversity: Measurement and assessment, Challenges and opportunity, Biodiversity monitoring, Measurement of species diversity, estimating species density Species abundance distributers, species occurrence and occupancy, measuring phylogenetic biodiversity, measuring biodiversity in managed landscape,

Practical:

Methods of behavioral observation; Instantaneous scan, focal animal, all occurrence and one-zero sampling, collection and analysis of behavioral data on few commonly seen species, preparation of ethograms, Demonstration of radio-telemetry methods to study activity patterns.

Suggested Readings

Lal, J.B. 1992. *Forest Ecology*. Natraj Publishers.

Waring, R. H. and Schlesigner, W.H. 1985. *Forest Ecosystem Concept and Management*. Academic Press, New York.

Ranga, M.N. 2012. *Wildlife Management and Conservation*. Agrobios, India.

Singh, S.K. 2015. *Textbook of Wildlife Management*. CBS Publisher, India.

Prater, S.H. 1998. *The Book of Indian Animals*. BNHS Oxford University Press.

Anne E. Magurran and Brian J. McGill. 2011. *Biological Diversity: Frontiers in Measurement and Assessment* 1st Edition. Oxford University Press.

Craig Chandler et al., 1983. *Fire in Forestry-Forest fire behavior and effects*: Vol-I.

Nicolas B. Peet et al., 1999. The conservation management of imperata cylindrical grassland in Nepal with fire and cutting: and experimental approach. *The Journal of Applied Ecology*. Vol-36 (3), pp 374-387.

WLS-523 Wildlife Population Dynamics 3(2+1)

Objective

The course will equip the students regarding Population density and regulation, predation, Population estimation, Sampling techniques, Recent techniques in Population estimation

Theory

UNIT-I

Population Density-Survival- Competeting Risk - Natality- Mortality -Life table -Kill curves; Fertility Schedule-Age structure -Male and Female -Reproduction potential; Population structure -Rate of increase- Fluctuations- Density stabilizing -Factors-Density Independent-Density dependent-Regulation;

UNIT- II

Carrying capacity-k and r factor -Predation- Theory of Predation- Prey -Predator Relationship; Management-Large predators- Domestic livestock; Foraging- Signs and Symptoms.

UNIT -III

Census- Planning -Organization-Observations -Records -Field notes -Datasheets; Methods -Direct Methods-Total Count-Complete count and Incomplete count- Aerial Count-Road Side count- Mark and Recapturing; Indirect Methods- Pug mark -Pellet count-Dung -Call Count-Kill Evidence;

UNIT- IV

Probability samplings- Steps in Samplings- Sample size- Accuracy -Precision; Size and Shape-Units- Plots-Strips-Clusters-Line transect- Concentric ships; Errors-data collection- Non-Sampling and Sampling; The King strip census- Kelker belt transect-Peterson Estimation-Chapman Robson method- Stochastic methods.

UNIT- V

Population Estimation-Amphibian -Reptiles; Population Viability Index (PVI) -Factors -Operation schedule-Lion- Elephants- Indian Guar-Antelopes; Camera trap methoc1- DNA-Scat-Dung Analysis; Wildlife Photography; Software- Data entry (WII) - Tiger -Wildlife Management and Information Systems.

Practical

Collection and preservation of biological specimens - Study of signs and symptoms -Recording basic field observations -Direct census methods. Indirect census methods- Camera Trap-Scat analysis- Microchip Method- Biotelemetry- Monitoring of larger Mammals- Primates-Carnivores-Birds- Reptiles- Amphibians- Population Viability Index -Wildlife Photography-Binoculars- Time and Trend analysis of population estimation- Statistical designs for population estimation. Attachment to a Wildlife sanctuary and National park will be made for 7 days to study the above topics.

Suggested Readings

Rajesh Gopal, 2010. *Fundamentals of Wildlife Management*. Justice Home, Allahabad, India.

Stephen, H.B. and V.B. Sahahria, 1995. *Wildlife Research and Management*. Oxford University, Press, Delhi.

Robert H.Giles 1984. *Wildlife Management Techniques* - Third Edition – Natraj Publisher Dehradun.

WLS-524 Ethology of Wild Animals 3(2+1)

Objective

The course will equip the students regarding patterns of animal behavior, behavioral mechanism, rhythms and communications, reproductive and social Behavior.

Theory

UNIT I

Animal behavior- Evolution-Reception- Sensory filtering- Responsiveness-Sign stimuli. -Instinctive behavior; Classical and modern concepts-Fixed action pattern and Ritualization; Learning-Imprinting habituation; Conditioning-Trial and Error learning-Reasoning and Insight leaning; Neural basis of leaming-Memory-Cognition-Sleep and Arousal; Analysis of behavior pattern- Taxis- Kinesis and Reflexes.

UNIT II

Physiological mechanism of behavior-Reflex Arc -Hormonal action -Perceptual-Role of hormones in drive- Pheromones in alarm spreading; Crypsis- Predator detection- Predator tactics; Altruism and evolution-Group selection, -Kin Selection-Reciprocal altruism; Migration-Domestication and behavioral changes

UNIT III

Biological rhythms- Circadian-Lunar Tidal -Annual rhythms- Behaviors during disasters; Receptors -Thermo-Tactile-Auditory- Visual -Chemo; Communications-Visual- Acoustics-Tactile-Chemical; Mimicry-Types; Foraging Behavior-Habitat selection -Optimality in foraging-Group foraging.

UNIT IV

Breeding seasons-Factors- Courtship- Display-Sexual Selection-Pair bond -Signs-Symptoms-Sexual dimorphism -Polymorphism-Polyandry- Polygamy-Promiscuity-Cooperative breeding-Brood parasites -Parental care- Behavior of Flagship Species.

UNIT V

Aggression -Intra specific- Inter specific; Social spacing -Territory -Dominance; Sexual Aggression- Parental Disciplinary -Weaning- Anti predatory; Social commensalism -mutualism -Parasitism - Social insects-Social behavior of Mammals.

Practical

Animal behavior-Social- Feeding- Breeding -Aggression- Recording- Reorganization- Signs and Symptoms of Primates under wild and captive condition; Biotelemetry-Small Herbivores-Aggression Behavior of Carnivores- Migration behavior- Case studies on Man monkey Conflicts- Cattle lifters- Man eaters.

Suggested Readings

McFarland D (ed.), 1981. *The Oxford Companion to Animal Behavior*, Oxford University Press, Oxford.

Leshner A I, 1978. *An Introduction to Behavioral Endocrinology*, Oxford University Press, New York.

Ridley M, 1968. *Animal Behavior- A concise Introduction*, Blackwell Scientific Publications, Oxford.

WLS-531 Wildlife Nutrition, Disease and Health Management 3 (2+1)

Objective

The course will equip the students regarding Wild Animal Nutrition, Nutritional Deficiency, Diseases of Carnivores Animals, Diseases of herbivores animals and Prevention and control of Disease and Zoonosis.

Theory

UNIT I

Nutrition-Principles -Importance; Ingestion - Digestion -Absorption-Transport -Utilization; Feed Composition-Organic Feed - Carbohydrate-Proteins-Lipids -Amino Acids-Vitamins - Inorganic Feed -Requirements; Feed resources-Herbivores-Carnivores -Prey and predator relationship -Complete feed-wild condition -Factors affecting feed requirement -Availability.

UNIT II

Mineral nutrition - Importance -Calcium-Phosphorous - Selenium + Iron-Deficiency Diseases-Role of Vitamins -Biotin -Thiamin - Carotene-Vit.A-Vit D-Vit,E-Vit C-Deficiency Disease - Muscular Dystrophy- Osteoporosis and Rickets

UNIT III

Diseases of Carnivores- Bacterial- Viral- Protozoan- Fungal- External & Internal Parasitic diseases of wild camivores- Parvo -Rabies- Canine Distemper-Erlichiasis -Taeniasis-Toxoplasmasis -Trichinosis- Filariasis-Sarcoptic mange -Pentastomiasis -Echinococcosis - Taeniasis -Hepatozoonosis-Emerging Infectious Diseases

UNIT IV

Diseases of Herbivores- Bacterial- Viral- Protozoan- Fungal- External & Internal Parasitic diseases of wild herbivores -Elephant pox- FMD-Tetanus- Leptospirosis- Tuberculosis-Salmonellosis-Haemairagic septicemia -Black quarters -Trypanosomiasis-Theileriasis-Babesiasis-Anthrax -B1ucellosis- Emerging Infectious Diseases

UNIT V

Disease-Prevention -Control - Zoonosis- Zooanthroponosis-Anthropozoonosis- Zoonotic Diseases-Rabies-Leptospira-Tetanus -Brucellosis-Flues-Human induced diseases -prevention-Vaccination-domestic animals in forest fringe areas.

Practical:

Surveillance of Disease- Epidemiology -General Guidelines for Disease precautions -Autopsy-biopsy - blood/serum-sample collection and dispatching for laboratory diagnosis. ~~Collection of external- internal parasites, Ration formation.~~ Feeding-young-adult herbivores-carnivores-Nutritional Deficiency -Metabolic profile test - dung analysis for parasitic eggs - scat analysis and parasitic eggs -Vaccination of domestic animals in forest fringe areas. Attachment will be made for 5 days in Veterinary Institute.

Suggested Readings

Pawar et al., 1984. *General Microbiology*.
Boyd WC. 1981. *Fundamental of Immunology.*
Wieser RS et al., 1971. *Fundamentals of Immunology*

WLS-532 Wildlife Crime, Legislation and Forensic Science 3(2+1)

Objective

The course will equip the students regarding over view of Wildlife crime, Wildlife products in trade, Importance of Forensic Science, Forensic Organizations and Conventions and legislations.

Theory

UNIT I

Introduction-Quantum of crime and trade, Importance -Wildlife crime and Offences -Poaching and smuggling-Internet as a tool-illegal wildlife trade- ~~Important seizures-National level and International level.~~

UNIT II

Important Wildlife species-their parts-products in trade; mammals-tiger-leopard -elephant - rhinoceros - antelope-musk deer-live bear -otters-pangolins; reptiles -skins of reptiles-snake venom-live reptiles; marine products-seashells -sea cucumber -sea horse -star tortoise -sharks - Rays -Corals; Live Birds-Medicinal and Aromatic plants.

UNIT III

Wildlife Forensics-Importance - Identification- wildlife specimens-parts-derivatives-differentiation from fake items-Sample types-Characterizing the type of sample -Case assessment -Validation-Presentation of evidence at court.

UNIT IV

Organizations in investigations -Scientific institutions -Wildlife Institute of India(WII) -Central Marine Fisheries Research Institute (CMFRI)-Botanical Survey of India (BSI) -Zoological Survey of India (ZSI) -Centre for Cellular and Molecular Biology (CCMB) ; Investigating departments-- State Forensic Labs-District Forensic Labs-Wildlife crime control bureau, Wildlife crime branch - State Wildlife departments-Central Bureau of Investigations (CBI)-Police Department; Non-Governmental Organizations-Trade Records Analysis of Flora and Fauna in Commerce (TRAFFIC)-World Wide Fund for nature (WWF) -Wildlife Protection Society of India (W PSI) -World Society for the protection of Animals (WSPA) -Tools and Resources for Applied Conservation and Enforcement (TRACE) -Wildlife Trust of India (WTI)

UNIT V

Indian Wildlife Protection Act 1972 -1991 Amendment to WPA -2003 Amendment to WPA - 2006 Amendment to WPA-Forest dwellers and Rights Act 2006 - National Wildlife Action Plan-National Biological Diversity Act, 2002 ; International conventions -Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) - International Union for Conservation of Nature (IUCN) ; Guidelines for preparation of Tiger Conservation plan for National Tiger Conservation Authority - Tiger task Force ; Guidelines for forest and wildlife Ecotourism ; Laws for protection of Wildlife in India-General Principle-Application - Indian Penal Code -Criminal Procedure Code -Indian Evidence Act -applied to wildlife crime.

Practical

Visit to Wildlife Crime Control Bureau -customs -police-forest department-To study activities of Crime control bureau-customs -police -forest department -convictions of persons involved in illegal trade in wildlife; Microscopic examinations in wildlife investigations (Hair profile, whiskers, skin, tooth, nail) -Species Identification using DNA loci-DNA profiling Markers in Forensics -Determining the geographic origin of animal samples. Visit to a Forensic Lab to study the procedures in Crime Investigations and to WCCB to study its activities for 4 days.

Suggested Readings

Adrian Linac 2009. *Foresnsic Science for Wildlife Investigation*, CRC press New York
Samir Sinha 2010. *Hand book on wildlife Law Enforcement in India,* Natraj Publisher.
Saharia VB, 1989. *Wildlife Law in India*, Natraj Publ.

WLS-533 Endangered Species Management 3(2+1)

Objective

The course will equip the students regarding over view of endangered species, Different organization working in protection and conservation of endangered species.

Theory

Introductory: terms and concepts of endangered species. Principal factors and causes of endangerment–habitat loss. Organisation setup and role of World Wildlife Fund (WWF), International Union for Conservation of Nature and Natural Resources (IUCN) and the Wildlife Institute India (WII) in endangered species management. Types of Endangered Species in India.Critically Endangered and Endangered Species in India. Some more critically endangered species. Policy during Ancient (Reign of Ashoka and Buddhism), Medieval and British India. Actions/Laws for Wild Life Conversation Chronologically in India: Protection of wild life under constitution of India.Protection of wild life under Indian Penal Code. Protection of endangered species at National and International level (Africa, Australia, China and USA). Critical analysis of endangered Species-current status. Statistics of Endangered Species in India.

Practical

Inventory of native endangered species. Inventory of exotic endangered species. Types of endangered species in India. Critically endangered species in India. Management strategies of endangered species. Visit of Wildlife Institute India (WII), Indian National Trust for Art, Culture and Heritage (INTACH), World Wildlife Fund for Nature (WWF) India and National Centre for Biological Sciences (NCBS) for 7 days to study the above topics.

Suggested Readings

Saharia, V.B. and Stephen Berwick, *Wildlife Research and Management*.
William J. Sutherland 2006. *Ecological Sensor Techniques a Handbook*. Cambridge University Press.
Anthony, R.E., Sinclair, John M.F., Graeme C. 2005. *Wildlife Ecology, Conservation and Management*. Blackwell, USA.

Minor Courses

STAT-512 Statistical Methods and Computer Application 3(2+1)

Objective

To impart basic knowledge in the student about statistical methods and application of computers in their research field.

Theory

UNIT I

Need for statistics in forestry experimentation and planning – population and sample. Correlation and regression: correlation coefficient/coefficient of determination, simple regression analysis; examples of multiple regressions. Examples of linear regression and its fitting by least square method.

UNIT II

Normal distribution and its application in forestry - properties of normal distribution. Confidence limits. Expected value of mean and standard error.

UNIT III

Tests of significance - Test for means in one sample and two sample cases (Z and t tests). Z-test for proportion, Chi-square test of variance in one sample case.

UNIT IV

F-test of variance in two sample cases. Test of equality of K - means (one way and two way classification). Probability, basic laws of probability.

UNIT V

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.

UNIT VI

Need for sampling in forestry. Complete enumeration Vs partial enumeration. Principal steps in sample surveys, population, sampling unit, size of sample, (sample intensity) bias, accuracy and precision. Sampling variation and estimation of sampling error. Determination of sample *size* for a given level.

UNIT VII

Classified sampling design used in forest surveys. Simple random sampling - stratified random sampling. Systematic sampling - Point sampling.

UNIT VIII

Basic principles of design of experiments, Uniformity trials and their uses, Fair field Smiths Variance Law and optimum size and shape of plots. Design and analysis of C.*R.D.* R.B.D. and L.S.D. with one observation per cell.

UNIT IX

Factorial experiments: Symmetrical and Asymmetrical factorial experiments, 2^n factorial experiments, Yates method and general method of analysis of AxB and AxBxC factorial experiments.

UNIT X

Layout and analysis of Split and Strip plot design. Missing plot technique in R.B.D. and L.S.D. with one observation missing.

UNIT X1

Transformations: Square root, Logarithmic and Angular transformation.

UNIT XII

Introduction to computer, MS Office, Statistical Application packages like MS-Excel, SPSS, R-software.

Practical

Laying out of designs in the field. Analysis of 2^2 and 2^3 experiments in R.B.D., Analysis of AxB factorial experiments. Analysis of AxBxC factorial 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. Analysis of results of the above design, Application of Statistical Packages like MS-Excel, SPSS, R-software with real forestry data.

Suggested Readings

V.G. Panse and P.V. Sukhatme (1985). *Statistical Methods for Agricultural Workers.* ICAR, New Delhi.

S.C. Gupta and V.K. Kapoor (2014). *Fundamentals of Mathematical Statistics*. Sultan Chand and Sons, New Delhi.

Sukthame and C. Ashok (1984). *Sampling Theories and Surveys with Application*. ICAR, New Delhi, 3rd ed.

G.N. Rao (1983). *Statistics for Agricultural Science*. Oxford and IBH, New Delhi.

Das, M.N. and Giri. N.C. (1986). *Design and analysis of Experiments. New Age* International Publishers.

Kingra, H. S., Singh, G. (1993). *Computer Basics for forestry*, International Book Distributors, Dehradun.

Rajaraman, V and Adabala, N. (2015). *Fundamentals of Computers,* Pearson Education, New Delhi.

SAF – 511 Forests and Climate Change 3(2+1)

Objective

Importance of forests and vegetation in the present era of climate change.

Theory

UNIT I

Weather and Climate, Climatic zones of India. Evaporation and transpirationcomponents of atmosphere, hydrosphere, pedosphere, biosphere and their interactions. Ecosystems of the world, Climate and its impact on agriculture, agro-climatic regions, soils and cropping patterns of India and agriculture productivity.

UNIT II

Climate change: Understanding climate change and its Consequences. Global warming and its effects on Forest

UNIT III

Forest and climate change: Vulnerability and adaptability - Evidence of forest disturbance due to climate change –Climate change influence on forests and agro-forestry- Climate resilient forestry.

UNIT IV

Economic worth of carbon storage in forest – Forest and UN convention on climate change - NATCOM initiatives – Decision making in emission of Green House Gases (GHG). Kyoto protocol, awareness about climate change.

UNIT V

National action plan for climate change – Green India mission- Indian Network for Climate Change Assessment (INCCA) - State Action Plans on Climate Change.

Practical

Layout of an agromet observatory and types. Measurement of wind and evaporation. Measurement of sunshine hours. Measurement of soil temperature and dew. Estimation of green house gases into atmosphere. Study of temperature instruments, pressure instruments, humidity instruments, wind instruments, rain instrument and wind rose. Solar radiation instruments with pyranometer.

Suggested Readings

Claussen E, Cochran VA & Davis DP. 2001. *Climate Change: Science, Strategies and Solutions*. Pew Centre on Global Climate Change, USA.

Koskela J, Buck A & Teissier du Cros E. 2007. *Climate Change and ForestGenetic Diversity: Implications for Sustainable Forest Managementin Europe*. Biodiversity International, Rome, Italy.

Ghadekar, S.R. (2003) Meteorology . Agromet Publishers, Nagpur

SAF- 512 Ecotourism and Participatory Forestry 3(2+1)

Objective

To impart knowledge to students regarding ecotourism in Indian context and its role for sustainable development of PA's.

Theory

UNIT I

Eco tourism - study history of tourism- identify various forms of tourism and evolution of ecotourism. Mass tourism versus ecotourism. Organized tours and Free Independent Travelers.

UNIT II

World Tourism Organization. Problems with definition of ecotourism and criticisms. Understand dimensions of ecotourism and the criteria to qualify for ecotourism. Different forms of ecotourism like hard and soft ecotourism.

UNIT III

Ecotourism indicators and conceptual differences between developing and developed countries. International organizations and NGOs promoting ecotourism. Sociological implications of eco-tourism. Protected areas in India - Ecotourism- a worldwide view. Ecotourism in Indian context. Planning ecotourism in protected areas. - Visitor management in ecotourism areas - zoning, carrying capacity.

UNIT IV

Participation of local people in ecotourism., PRA and RRA, Ecotourism for sustainable development of PA's. New directions in ecotourism industry. Ecotourism in practice in important PA's of India - case studies Limitations and problems of ecotourism.

UNIT V

Ecotourism as a way for sustainable management of natural resources. Local livelihoods and eco-tourism like nomadic grazing, agro- pasturatism). Desiging and landscaping in ecotourism. Design and management of ecotourism. Economics of ecotourism. Modern Research approaches on Eco-tourism.

Practical

Students should make detailed reference on the various forms of Ecotourism in the World. Visit to various ecotourism areas and identify the tourism components- suggest modifications. Exercises on the blending of local cultural and sociological heritage with the various forms of ecotourism. Problems on common property resources and facilitate group discussion for recommendations. Evaluation and monitoring of the various ecotourism activities of the region such as Nature Walk - The guided day trek, The Tiger Trail, Border Hiking, Bamboo Rafting, Jungle Patrol, Tribal Heritage, Jungle Inn, The Sacred groves, Bamboo Grove, Green Mansions, the backwater cruise. Identify an area where ecotourism in vogue- Identity the various ecosystem activities in the selected area, evaluate in terms of economic feasibility, ecological adaptability and social acceptance. Climate change and its influence on carbon economy. Study the carrying capacity and impact of ecotourism activity on the ecosystem, suggest recommendation to overcome the ill effects of ecotourism.

Suggested Readings

Baker CP. 1996. *World Travel: A Guide to Intenational Eco Journeys*. Warner Books.

Honey M. 1998. *Ecotourism and Sustainable Development*. Iceland Press.

Luck M & Kirstges T. 2002. *Global Ecotourism Policies and Case Studies*. Channel View Publ.

Neale G. 1999. *Green Travel Guide*. Earth Scan.

WLS-511 Captive animal and Biological Parks Management 3(2+1)

Objective

To acquaint the students aboutEx-situ Conservation, Captive Animal Management, Rescue and Rehabilitation, Captive Breeding and Breeding Program for Keystone and Species Biological Parks Management.

Theory

UNIT I

Ex situ Conservation-Scope-Importance; Zoos-Design -Layout -Types - Functions -Barriers -- Recommendations of Expert committee-Enclosures and Exhibitions-Safari parks - Administration- Zoological gardens in India;

UNIT II

Central Zoo Authority (CZA) -Roles -Regulations-World Association of Zoos and Aquariums; Captive Management-Principles-Nutrition and Feeding -Housing -sanitation Care and protection; Zoo Management-Strategies-Large Mammals -Elephant-Rhinoceros - Hippopotamus- Gaur -Carnivores -Lion -Tiger-Panther-Primates -Reptiles-Avifauna -Butterfly Park.

UNIT III

Restraints-Need -Types-Psychological Restraint-Physical-Trapping Methods-Conventional -Pit capture -Nooses-Metal Traps-Box Traps -Nets -Corral- Physical Examination -Chemical Restraint-Procedures- Method-injection of drugs-Peripherally acting drugs-Centrally acting drugs-Factors affecting dung action; Relocation-Procedure-Guidelines-Quarantine Measures.

UNIT IV

Breeding-Need-Principles-Constraints -Impact -Merits and Demerits; Pheromones -Artificial administration Inbreeding -Out Breeding-Cross Breeding-Grading-Top crossing - Criss crossing; Captive breeding-programmes -India; Stem cell research-Cloning. Special Breeding Projects-House Keeping -Care -Nutrition -- Feeding -Sanitation -Crocodile - Snakes -Primates - Carnivores-Camp Elephants; Special Projects-Impact -Zoo Education-Awareness programmes.

UNIT V

Essentials and concepts of Biological Parks. Components of Biological Parks. Monitoring and spatial distribution of Biological Parks. Education-Awareness programmes of Biological Parks. Ecological role of Biological Parks in environment.

Practical

Visit to the Zoological parks- Design and Layout -Conventional Zoo-Modern Zoo -Enclosures and Exhibition - Housing -Sanitation ; Handling of Captive animals -Reptiles -Primates - Carnivores-Larger Mammals-Age and Sex determination; Sample collection from animals-Postmortem - wild animals in Captive condition ; Procedures for introduction of exotic species ; Procedure-rescue and relocation-larger mammals - carnivores-Drugs and Equipment's ; Zoo Awareness program -Case Studies on Concept of Adopting Captive animal.

Attachment to a Modern Zoological Garden and Biological Parks will be made for 5 days to study the above topics.

Suggested Readings

Rajesh Gopal, 2010. *Fundamentals of Wildlife Management*. Justice Home Allahabad, India.

Sale, J.B, and K. Berkmuller. 1988. *Manual of Wildlife Techniques for India*. WII, FAO, Dehradun, India.

Stephen, H.B. and V.B. Saharia, 1995. *Wildlfe Research and Management*. Oxford University, Press, Delhi.

WLS-534 Wildlife Photography, Nature Interpretation and Education 3(2+1)

Objective

To acquaint the students about Introduction to wildlife photography, its scope and opportunities

Theory

Fundamentals of Photography: DSLR Camera and Accessories, understanding various types of camera, Classification of cameras. Types of cameras available, types of DSLR cameras and various digital cameras, construction of digital image sensor, pixels and resolutions. Introduction to various modes in DSLR camera, Priority modes - Aperture priority mode, Shutter Speed priority mode, program mode, other modes and understanding of manual mode. Exposure and Metering in DSLR Camera. Focus and depth of field, image quality and histograms, color balance and picture style, foundation of light. Behavior of wild animals Understanding the composition and framing of images, use of different shots and angles in photography. Photography applying rules and apply wildlife photojournalism. Introduction to macro photography, its scope and opportunities, various accessories for macro photography, macro lenses, extension tubes, reverse ring and ring flash useful for macro photography. The use of macro for natural world and the tricks to capture them effectively and creatively. Introduction to wildlife photography, its scope and opportunities. Acquaintance with tele lens, tele converter useful for wildlife photography. Essentials of nature and nature interpretation center. Importance of nature interpretation center in wildlife. Various methods of wildlife education. Mass scale awareness and among people of every strata.

Practical

Exposure to wildlife photography equipment's. Do's and don'ts in wildlife Photography. Photography of various groups of wildlife (Mammals, Birds, reptile and Amphibians). Acquaintance with the art of capturing best wildlife moments. Understanding of the wildlife, knowing how to deal with the wildlife, bird identification and behavior, understanding the method for tracking animals and birds. Visit of Nature Interpretation Centre and Biological Parks.

Suggested Readings

John and Barbara Gerlach, 2013, *Digital wildlife Photography*.
Jim Harmer and Smashwords, 2010, *Improve your wildlife photography*
UweSkrzypczak, 2009, *Wildlife photography*.
Laurie Excell, 2012, *Wildlife Photography*: From Snapshots to Great Shots.
Frederick S. Schaeffer, *Bird Photography*, North American BirBander, Vol. 2,
Scott Kelby, 2013, *The digital Photography*.

WLS-535 Man -Animal Conflict 3(2+1)

Objective

To acquaint the students about different types of human and wild life interactions

UNIT I

Definition, Introduction: Man vs. Nature; human and wild life interactions; types of interactions. Extent of forests in India, present scenario of forests in India and estimated population of wild animals; Causes and nature of declining forests area, extend of forest corridor, Challenges and threats to the Indian wildlife.

UNIT II

Human-wildlife conflict indicators, types of man animal conflicts; some related case studies of important wildlife species.

UNIT III

Causes of man animal conflicts; road kills, increase in human population, land use transformation, deforestation - habitat loss, habitat fragmentation and shrinkage -Exotics-wildlife trade; poaching & over exploitation; some related case studies.

UNIT III

Effects of human wildlife conflict, Mitigation and management measures of man animal conflicts; traditional and modern methods.

UNIT IV

Law and policy by Govt.of India; policy imperatives; some related case studies.

UNIT V

Overview of man-animal conflicts and mitigation measures adopted in India and worldwide.

Practical

Man -animal conflicts: leopard, tiger, elephant, bear, snake, etc. Man -animal conflicts; recent cases reported in different parts of country. Railway and road kills with recent examples. Analysis of man-animal conflicts and mitigation measures adopted in India and worldwide.

Suggested Readings

Barua Mann (2010), *Human-Wildlife Conflict & 21st Century Conservation*, Reading Group Outline, University of Oxford.

www.env.gov.yk.co/wildlifebiodiversity /human_wildlife_conflict.

www.conservationthreates.org

http://wgbis.ces.iisc.ernet.in/energy/water/paper .Human – Animal Conflicts Further Shrinkage of Habitat and Fragmentation of Animal Corridors will Enhance Human – Animal Conflicts.

C.M. Hill, F.Y. Osborn & A.I. Plumptre (2002), *Human Wildlife Conflict Identifying problem and possible solutions*, Albertine Rift Technical Report series Vol I Wildlife Conservation Society, International Union for the Conservation of Nature and Natural Resources(IUCN.)

M.Zoe Warner (2008), *Examining Human-Elephant Conflict in Southern Africa: Causes and Options for Coexistence, Master of Environmental Studies* Capstone Project Department of Earth and Environmental Studies, University of Pennsylvania .

NRM- 512 Land use and Watershed Management 3(2+1)

Objective

To impart knowledge to students regarding Watershed characteristics, Components of natural resources for watershed management, People participation in watershed management

Theory

UNIT I

Soil and Land, Land use patterns in India and Rajasthan, Soil survey and land use planning –soil types, fertility, productivity, erosion and conservation practices. Water resource development, water availability, pressurized irrigation crop water requirements and water use efficiency. Biota- vegetation types, distribution and utilization.

UNIT II

Historical background, Multiple use concept, Watershed characteristics, Employment and Income generation, Sustainability and Equity issues. Formulation of watershed projects (micro and macro watershed).

UNIT III

Components of natural resources for watershed management. Preparation techniques for micro plan of watershed. Impact assessment techniques for upliftment of socio-economic status and environment. Valuing Inputs and Outputs.

UNIT IV

Watershed survey, mapping and structural engineering designs-Compass, Surveying, Plane table surveying, Leveling, Preparation of contour maps of watershed. Terraces and bunds- types & design.

UNIT V

Soil and water conservation and water harvesting structures – types & design. Sedimentation- sources, estimation of sediment bank treatment techniques. Hydrological cycle and characteristics of small and medium watersheds precipitation, infiltration, run-off (run-off hydrographs) total and peak, soil moisture, hydrograph, ground water and evapo-transpiration. Resources inventory soil, land, water and Biota.

UNIT VI

People participation and impact analysis in watershed management- Community organizations – Definition, Principles advantages, Community mobilization. Psychodynamics of group processes decision making, leadership, and conflict management and group strategies. Participatory planning, implementation, monitoring and evaluation. Participatory research approaches. Socio economic impact analysis, financial analysis.

Practical

Survey of watershed, Preparation of micro-plan and planning of watershed for effective implementation. Study of hydrological equipment; Measurement and analysis of rainfall data; Estimation of runoff using rational formula; Preparation, use and analysis of hydrograph; Measurement of evaporation by different methods; Study of flood control reservoirs; Exercises on economic profitability of various land-based enterprises bases in cost and revenue concepts. Preparation of contour maps, Estimation of earth work, Design of check dams, Acquaintance with water lifting devices, Use of measurement, Conveyance and control structures.

Suggested Readings

Moorthy VVN. 1990. *Land and Water Management*. Kalyani.
Murty, J.V.S. 1995. *Watershed Management in India*. Wiley Eastern, New Delhi.
Oswal MC. 1999. *Watershed Management (For Dryland Agriculture),* Associated Pubg Co., Delhi.
Rajora R. 1998. *Integrated Watershed Management*. Ravat Publ., New Delhi.
Dhuruva Narayana, V.V., Sastry, G. and Patnaik, V.S. 1990. *Watershed Management*. ICAR Publication, New Delhi.

NRM – 531 Remote sensing and Geographic Information System 3(2+1)

Objective

Importance Remote sensing, components of Digital image processing, image analysis and classification, Use of GIS and GPS. Use of GIS software in Forestry.

Theory

UNIT I

Orientation to subject- use History and use of aerial photography, Satellite imagery and geographic information system

UNIT II

GIS for the collection, storage and spatial analysis for geo-referenced forest resources data and information.

UNIT III

The integration of spatial data analysis systems with knowledge-based systems and/or simulation systems for the development of information/decision support systems for forest management

UNIT IV

Satellite systems; satellite imageries – techniques, uses and limitation, Future prospects of remote sensing in India

UNIT V

Software used in remote sensing; GIS versus remote sensing; GIS Software used in forestry and environments, Analysis of data; Application of GIS in forestry.

Practical

Uses of various photogrammetry instruments, Recognition and identification of objects on photography, Compilation of maps and their interpretation, Hands on practice on remote sensing software, Hands on practice on GIS software

Suggested Readings

Burrough P.A.1990. *Principles of GIS for Land Resources Assessment*. Oxford and IBH.

Lillsand T. M.1989. *Remote Sensing and Image Interpretation*. John Wiley.

Narayanan L.R.A. 1999. *Remote Sensing and its application*. University Press(India)/Orient Longman.

Sharma, N. K. 1986. *Remote Sensing and Forest Survey*. IBD, Dehradun.

Non-credit Courses

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

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.

To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, 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 article.

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

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.

Collins' Cobuild English Dictionary. 1995. Harper Collins, London

Gordon HM and Walter JA. 1970. *Technical Writing.* 3rd Ed. Holt, Rinehart and Winston.

Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English.* 6th Ed. Oxford University Press, Oxford

James HS. 1994. *Handbook for Technical Writing.* NTC Business Books.

Joseph G. 2000. *MLA Handbook for Writers of Research Papers.* 5th Ed. Affiliated East-West Press.

Mohan K. 2005. *Speaking English Effectively.* MacMillan India.

Richard WS. 1969. *Technical Writing.* Barnes & Noble.

Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language.* Abhishek. Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English.* 2nd Ed. Prentice Hall of India.

Wren PC & Martin H. 2006. *High School English Grammar and Composition.* S. Chand & Co. New Delhi.

PGS- 503 Intellectual Properties And Its Management In Agriculture (1+0)

Objective

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

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers' rights and biodiversity protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings

Erbisch FH and Maredia K. 1998. *Intellectual Property Rights in Agricultural Biotechnology.* CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy.* McGraw-Hill, New Delhi.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC and Aesthetic Technologies.

Ministry of Agriculture, Government of !ndia. 2004. *State of Indian Farmer.* Vol. V. *Technology Generation and IPR Issues.* Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics.* CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies.* Daya Publ. House, New Delhi.

The Indian Acts - Patents Act, 1970 and amendments; Design Act, 2000; Trademarks Act, 1999; The Copyright Act, 1957 and amendments; Layout Design Act, 2000; PPV and FR Act 2001, and Rules 2003; National Biological Diversity Act, 2003.

PGS- 506 Disaster Management (1+0)

Objective

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

Theory

UNIT I

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

UNIT II

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

UNIT III

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

Suggested Readings

Gupta HK. 2003. *Disaster Management.* Indian National Science Academy. Orient Blackswan.

Hodgkinson PE and Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management.* Routledge, London.

Sharma VK. 2001. *Disaster Management.* National Centre for Disaster Management, India.

Non -credit Deficiency Courses

(Required to be offered by the students not having B.Sc. Forestry degree programme)

FORT -451 Practices of Silviculture 3(2+1)

Objective

To acquaint the students about general practices of silviculture in India and Rajasthan with examples of important trees.

Theory

UNIT I

Definition of forest and forestry. Classification of forest and forestry, branches of forestry and their relationships. Definition, objectives and scope of Silviculture. Status of forests in India and their role. History of forestry development in India.

UNIT II

Trees and their distinguishing features. Growth and development. Forest reproduction - flowering, fruiting and seeding behaviour. Natural, artificial and mixed regeneration. Natural regeneration - seed production, seed dispersal, germination and establishment. Requirement for natural regeneration.

UNIT III

Dieback in seedling with examples. Plant succession, competition and tolerance. Forest types of India and their distribution.

UNIT IV

Silvicultural systems-definition, scope and classification. Systems of concentrated regeneration- systems of diffused regeneration- accessory systems- Clear felling systems- Shelterwood system - Selection system and its modifications- Coppice systems- Culm selection system in Bamboo, Canopy lifting system in Andaman. Silvicultural systems followed in other countries

UNIT V

Tree planting- Sowing v/s planting different kinds of pits. Tending operations - weeding, cleaning, thinnings, definitions, objectives and methods, increment felling and improvement felling. Pruning and lopping. Control of climbers and undesirable plants.

UNIT VI

Rotation -definitions-various types of rotations-length of rotations-choice of type and kind of rotation. Normal forest-definitions basic factors of normality. Factors governing the yield and growth of forest stands-Working plan-preparations, -objectives and uses

Practical

Acquaintance with various technical terms. Visits to different forest areas/types. Study of forest composition. Recording the observations on shoot development, growth rings, crown development, leafing, flowering and fruiting in a few selected tree species. Study of site factors like climatic, edaphic, physiographic and biotic. Study of forest succession. Study of the afforestation and reforestation success.

Suggested Readings

Dwivedi AP. 1992. *Agroforestry: Principles and Practices.* Oxford and IBH, New Delhi.

Khanna LS. 1996. *Principle and Practice of Silviculture.* International Book Distributors, Dehradun.

Dwivedi AP. 1993. *A Text Book of Silviculture.* International Book Distributors, Dehradun

Khanna L. 1996. *Principles and Practices of Silviculture.* International Book Distributors, Dehradun

Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. *The Practices of Silviculture-applied Forest Ecology.* John Wiley and Sons, New York.

FORT -452 Forest Products and Utilization 3(2+1)

Objective

To acquaint the students about various forest products, availability of raw material and best utilization practices in India.

Theory

UNIT I

Introduction, methods of collection, management and importance of Non-Wood Forest Products (NWFP). Fodder (grasses and tree leaves), canes and bamboos. Essential Oils - methods of extraction, classification, storage and uses. Non-Essential oils – nature, occurrence, methods of extraction, classification and uses. Important fixed oil yielding trees.

UNIT II

Gums and resins –definition, classification, sources, collection and uses. Factors affecting gum formation. Important gum yielding plants. Resins and Oleoresins, their formation in plants and classification of resins. Tans- nature, classification, uses and important tannin yielding plants. Dyes – classification and sources of dyes. Beedi leaves – sources, collection and processing. Fibers and flosses. Katha and Cutch – sources, extraction and uses. Drugs, wild fruits and vegetables, spices, poisons and bio-pesticides. Honey, Lac, and silk- their importance, extent and processing.

UNIT III

Pulp and paper industry. Introduction and raw material; pulping mechanical, chemical, semi-chemical and semi-mechanical; pulp bleaching; stock preparation and sheet formation; types of paper; manufacture of rayon and other cellulose derived products.

UNIT IV

Manufacture, properties and uses of Composite wood- plywood, fiberboard, particleboard and hard board.

UNIT V

Adhesives used in manufacture of composite wood. Improved wood, definition, types (impregnated wood, heat stabilized wood, compressed wood, and chemically modified wood). Destructive distillation of wood. Scarification of wood. Production of wood molasses, alcohol and yeast.

Practical

Visit to paper industry to study pulp and papermaking. Study of different types of papers. Study of different types of paper boards. Visit to Rayon industry. Visit to plywood industry to study the manufacturing processes. Study of plywood, fiberboards, particleboards, and hard boards. Visit to other wood-based industries. Visit to wood distillation unit. Visit to nearby industrial plantations. Study of types of improved wood.

Suggested Readings

Anonymous. 1981. *Wealth of India*. CSIR Publ., New Delhi.
Anonymous. 2007. *Year Book of Forest Products*. FAO.
Dwivedi AP. 1993. *Forestry in India*. Surya Publ., New Delhi.

FORT -453 Dendrology and Forest Botany 3 (2+1)

Objective

To acquaint the students about various forest plants and trees, their identification and systematic.

Theory

UNIT I

Introduction – importance and scope of dendrology, Morphology of woody plants and range of variation. Principles and systems of classification of plants. Bentham and Hooker's, Engler and Prantles, and Hutchinson's Systems. Plant Nomenclature – objectives, principles and International Code of Botanical Nomenclature.

UNIT II

Role of vegetative morphology in identification of woody forest flora. Peculiarities of tree stems, twigs, general form of woody trunk and deviations like buttresses, flutes, crooks, etc. Morphology and description of barks of common trees. Characteristics of blaze on bark, colour, gums, latex, etc.

UNIT III

Morphology of leaf, description of different types of leaves, colour of young and old leaves in some species as (regular) features of identification. Reproductive morphology of plants with reference to description and identification of reproductive parts.

UNIT IV

Floristics and procedures; herbarium techniques, collection, processing and preservation of plant material. General study of herbarium, arboretum and xylarium. Description of the plant in scientific terms, study of sport characteristics of plants, naming and classifying based on adopted system.

UNIT V

Study of families, as survey of forest resources: Magnoliaceae, Rhizophoraceae, Ebenaceae, Sapotaceae, Santalaceae, Papilionaceae, Caesalpiniaceae Mimosaceae, Elaeagnaceae, Meliaceae, Salicaceae, Rutaceae, Apocynaceae, Betulaceae, Verbenaceae, Fagaceae, Asteraceae, Moraceae, Poaceae, Tiliaceae, Euphorbiaceae, Myrtaceae and Combretaceae, Liliaceae, Pinaceae, Dipterocarpaceae, Cupressaceae, Guttiferae, Taxaceae,.

UNIT VI

Geographical distribution of important Indian trees, native trees, exotic trees, endemism, allelopathy with respect to forest trees.

Practical

Morphological description of plant parts and method of collection of plants. Techniques of preparing herbarium specimens. Study of woody flora of: Magnoliaceae, Ebenaceae and Tiliaceae; Papilionaceae, Caesalpiniaceae and Mimosaceae;; Moraceae and Poaceae; Meliaceae, and Salicaceae; Apocynaceae; Combretaceae, Myrtaceae and Santaleceae; Asteraceae, Sapotaceae and Verbenaceae; Euphorbiaceae and Liliaceae.

Suggested Readings

Bhandari, M.M. (1978). *Flora of Indian Desert*, Scientific Pub., Jhodhpur, Pp. 471.

Bor, N.L. (1996) *Manual of Indian Forest Botany*, IBD Pub., Dehradun, Pp. 441.

Brandis, D. (1874). *The Forest Flora of North-west and Central India* (Repr. Ed. 1972). Bishen Singh & Mahendra Pal Singh, Dehradun, India.

Chauhan, P.S. (2006). *Biodiversity Assessment Survey of Hadoti Region, Rajasthan-PartII: Floral Diversity of Jhalawar and Kota Districts,* Technical report submitted to College of Horticulture and Forestry, Rajathan, Pp. 27+Appendix-1+III Plates.

Chauhan, P.S., Manmohan, J.R., Prahlad, V.C. and Pandey S.B.S. (2006). *Practical Manual on Dendrology for B. Sc. (Forestry); submitted to College of Horticulture and Forestry,* MPUAT. Rajasthan, Pp. 44.

Dasgupta, S. (1988). *Systematic Botany for Foresters,* Khanna Bandhu Pub., Dehradun, Pp. 210.

Datta, S. C. (1988). *Systematic Botany*, New Age International pub., Pp. 653

Harlow, William M., Editor (1995). *Textbook of Dendrology*, Authors, Ellwood S. Harrar, James W. Hardin, Fred M. White), McGraw-Hill Companies, Pp. 534.

Krishen, Pradeep (2006). *Trees of Delhi-A Field Guide,* DK Pub., India, Pvt. Ltd. New Delhi, Pp.360.

Kumar, Ashok (2001). *Botany in Forestry and Environment*, Kumar Media Pvt. Ltd., Dehradun, Pp. 716.

Naik V. N. (2003). *Taxonomy of Angiosperms*,

Pandey, B.P. (1978). *Economic Botany,* S Chand Pub., Pp.534.

Sharma, N. (2002). *The Flora of Rajasthan*, Avishkar Pub Distributors, Jaipur, Pp.208.

Singh, V. and D.K. Jain (2006). *Taxonomy of angiosperms,* Rastogi publications.

SYLLABUS

For

M.Sc. Horticulture

2018-19

FACULTY OF HORTICULTURE
AGRICULTURE UNIVERSITY, KOTA

ANNEXURE-I

Course Curriculum of M.Sc. Horticulture

Semester-I

S.No.	Course No.	Course Title	Cr. Hrs
1	HORT – 511	Tropical and Dry Land Fruit Production	3 (2+1)
2	HORT – 512	Production Technology of Cut Flowers	3 (2+1)
3	HORT – 513	Production Technology of Warm Season Vegetable Crops	3(2+1)
4	STAT – 511	Statistical Methods	3 (2+1)
5	HORT – 514	Biotechnology and Horticultural Crops	3 (2+1)

Semester-II

S.No.	Course No.	Course Title	Cr. Hrs
1.	HORT – 521	Biodiversity and Conservation of Fruit Crops	3 (2+1)
2.	HORT – 522	Sub-Tropical and Temperate Fruit Production	3 (2+1)
3.	HORT – 523	Production Technology of Cool Season Vegetable Crops	3 (2+1)
4.	HORT – 524	Production Technologies of Spice Crops	3 (2+1)
5.	HORT – 525	Breeding of Vegetable Crops	3 (2+1)
6.	HORT – 526	Post Harvest Micro Biology of Horticultural Produce	3 (2+1)
7.	HORT – 527	Post Harvest Handling of Horticultural Crops	3 (2+1)
8.	HORT - 528	Landscape and Ornamental Gardening	3 (2+1)
9.	HORT – 529	Production Technology of Loose Flowers	3 (2+1)
10.	STAT – 521	Design of Experiment - I	3 (2+1)
11.	PGS-502 (e-course)	Technical Writing and Communication Skills	1 (0+1)

Semester-III

S.No.	Course No.	Course Title	Cr. Hrs
1.	HORT – 531	Principles of Post Harvest Technology of Horticultural Crops	3 (2+1)
2.	HORT – 532	Growth and Development of Horticultural Crops	3 (2+1)
3.	HORT – 533	Breeding of Fruit Crop	3 (2+1)
4.	HORT – 534	Breeding of Flower Crops and Ornamental Plants	3 (2+1)
5.	HORT – 535	Propagation and Nursery Management of Horticultural crops	3 (2+1)
6.	HORT – 536	Processing and Preservation of Horticultural Crops	3 (2+1)
7.	HORT – 537	Analytical Techniques for Fresh and Processed Horticultural Produce	3 (2+1)
8.	HORT – 538	Seed Production Technology of Vegetable Crops	3 (2+1)
9.	HORT – 539	Production Technology of Under Exploited Vegetable Crops	3 (2+1)
10.	HORT – 540	Protected Floriculture	3 (2+1)
11.	PGS-503 (e-course)	Intellectual Property and its Management in Agriculture	1 (1+0)
12.	PGS-506 (e-course)	Disaster Management	1 (1+0)

S. No.	Course No.	Course Title	Cr. Hrs
1	HORT-541	Seminar	1 (1+0)
2	HORT-591	Comprehensive	NC
3	HORT-599	Research	20

ANNEXURE-II

MODIFIED COURSE CONTENT OF THE PG COURSE CURRICULUM

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 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.

Pradeepkumar 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 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 CO_2 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, 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 and Landscaping.* Naya Prokash.

Chadha KL & Chaudhury B. 1992. *Ornamental Horticulture in India*. ICAR.

Chadha KL. 1995. *Advances in Horticulture.* Vol. XII. Malhotra Publ. House.

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 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 and cowpea

UNIT III- Cucurbitaceous crops

UNIT IV- Tapioca and sweet potato

UNIT V- Green leafy warm season vegetables

Practical

Cultural operations (fertilizer application, sowing, mulching, irrigation, weed control) of summer vegetable crops and their economics; study of physiological disorders and deficiency of mineral elements, preparation of cropping schemes for commercial farms; experiments to demonstrate the role of mineral elements, physiological disorders; plant growth substances and herbicides; seed extraction techniques; identification of important pests and diseases and their control; maturity standards; economics of warm season vegetable crops.

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.

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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.

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.

Saini GS. 2001. *A Text Book of Oleri and Flori Culture*. Aman Publ. House.

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. 2004. *Vegetables, Tuber Crops and Spices*. ICAR.

Thompson HC & Kelly WC. (Eds.). 1978. *Vegetable Crops*. Tata Mc Graw Hill.

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.

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 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
UNIT III: Litchi, loquat, persimmon, kiwifruit, strawberry
UNIT IV: Nuts- walnut, almond, pistachio, pecan, hazelnut
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 commercial orchards.

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 523 PRODUCTION TECHNOLOGY OF COOL SEASON VEGETABLE CROPS 2+1

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. 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. 1951. *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.

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 524 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 experiments 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

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 and Spices*. ICAR. Tiwari RS & Agarwal A. 2004. *Production Technology of Spices*. International Book Distr. Co.

Varmudy V. 2001. *Marketing of Spices*. Daya Publ. House.

VSC 525 BREEDING OF VEGETABLE CROPS 2+1

Objective

To educate principles and practices adopted for breeding of vegetable crops.

Theory

Origin, botany, taxonomy, cytogenetics, genetics, breeding objectives, breeding methods (introduction, selection, hybridization, mutation), varieties and varietal characterization, resistance breeding for biotic and abiotic stress, quality improvement, molecular marker, genomics, marker assisted breeding and QTLs, biotechnology and their use in breeding in vegetable crops-Issue of patenting, PPVFR act.

UNIT I- Potato and tomato

UNIT II- Eggplant, hot pepper, sweet pepper and okra

UNIT III- Peas and beans, amaranth, chenopods and lettuce

UNIT IV- Gourds, melons, pumpkins and squashes

UNIT V-Cabbage, cauliflower, carrot, beetroot, radish, sweet potato and tapioca

Practical

Selection of desirable plants from breeding population observations and analysis of various qualitative and quantitative traits in germplasm, hybrids and segregating generations; induction of flowering, palanological studies, selfing and crossing techniques in vegetable crops; hybrid seed production of vegetable crops in bulk. screening techniques for insect-pests, disease and environmental stress resistance in above mentioned crops, demonstration of sib-mating and mixed population; molecular marker techniques to identify useful traits in the vegetable crops and special breeding techniques. Visit to breeding blocks.

Suggested Readings

Allard RW. 1999. *Principles of Plant Breeding*. John Wiley & Sons.

Basset MJ. (Ed.). 1986. *Breeding Vegetable Crops*. AVI Publ.

Dhillon BS, Tyagi RK, Saxena S. & Randhawa GJ. 2005. *Plant Genetic Resources: Horticultural Crops*. Narosa Publ. House.

Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.

Gardner EJ. 1975. *Principles of Genetics*. John Wiley & Sons.

Hayes HK, Immer FR & Smith DC. 1955. *Methods of Plant Breeding*.McGraw-Hill.

Hayward MD, Bosemark NO & Romagosa I. (Eds.). 1993. *Plant Breeding-Principles and Prospects*. Chapman & Hall.

Kalloo G. 1988. *Vegetable Breeding*. Vols. I-III. CRC Press.

Kalloo G. 1998. *Vegetable Breeding*. Vols. I-III (Combined Ed.). Panima Edu. Book Agency.

Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

Paroda RS & Kalloo G. (Eds.). 1995. *Vegetable Research with Special Reference to Hybrid Technology in Asia-Pacific Regio*n. FAO.

Peter KV & Pradeepkumar T. 2008. *Genetics and Breeding of Vegetables.* Revised, ICAR.

Rai N & Rai M. 2006. *Heterosis Breeding in Vegetable Crops*. New India Publ. Agency.

Ram HH. 1998. *Vegetable Breeding: Principles and Practices*. Kalyani.

Simmonds NW. 1978. *Principles of Crop Improvement*. Longman.

Singh BD. 1983. *Plant Breeding*. Kalyani.

Singh PK, Dasgupta SK & Tripathi SK. 2004. *Hybrid Vegetable Development*. International Book Distributing Co.

Swarup V. 1976. *Breeding Procedure for Cross-pollinated Vegetable Crops*. ICAR.

HORT- 526 Post Harvest Microbiology of Horticultural Produce (2+1)

Theory:

Importance of horticultural crops in dietary, chemical Composition, nutritive value and perishable nature of fresh and processed horticultural produce. Contamination and spoilage of fresh fruits and vegetables, types of spoilage in processed products such as canned fruits and vegetables, dehydrated, frozen foods, pickles, beverages etc., intrinsic and extrinsic parameters that affect microbial growth and their control measures, principles and methods of food preservation. Important microorganisms associated with food, their classification, nomenclature & multiplication. Importance of microorganisms in food industry, fermentation processes, production of various by- products, vinegar, fermented beverages, etc. Food borne diseases and food poisoning, importance of hygiene and sanitation. Safety and Quality control of fruit and vegetable products, biochemical and microbiological examinations.

Practical:

Analyzing perishability of fruits and vegetables, study of morphology of microorganisms, preparation of bacteriological media, culturing of microorganisms, microbiological examination of processed products, types of fermentations, biochemical and enzymatic tests.

Suggested Readings:

1. **Pelezer, M.J., Chan, E.C. and Krieg, N.R.** (1993). Microbiology concepts and applications. McGraw Hill Publishing Co., Inc., New York.
2. **Frazier, W.C. and Westhoff, D.C.** (1988). Food Microbiology. McGraw Hill Publishing Co., Inc., New York.
3. **Purohit, S.S.** (1994). Microbiology- Fundamentals and Application. 5th Edition., Agro Botanical Publishers, Bikaner, India.
4. **Khetarpaul, Neelam** (2005). Food Microbiology. Daya Publishers, New Delhi.

HORT- 527 Post Harvest Handling of Horticultural crops (2+1)

Theory:

Maturity indices of horticultural crops. Harvesting and its relationship with quality, Sorting and grading, Pre-harvest crop management practices and their influence on quality during storage and marketing. Respiration, Ethylene in post-harvest biology, Technology of artificial ripening and de-greening of fruits. Physiology of ripening and senescence. Storage disorders including chilling injury. Application of growth regulators for quality assurance. Post-harvest treatments: Pre cooling, Heat treatments (hot water, hot air and Vapour heat), fungicides & biologically safe chemicals, Irradiation, Curing, Pulsing etc. Packing line operations, Packaging of horticultural produce. Transportation- rail, road, sea, air; Codex norms for export of perishables. Storage systems: On – farm storage - evaporatively cooled stores, ventilated storage, pit storage etc. Refrigerated storage of horticultural produce, Refrigeration cycle, Controlled / Modified Atmosphere, Hypobaric, Hyperbaric storage.

Practical:

Practice in judging the maturity of various horticultural produce, determination of physiological loss in weight and quality. Grading of horticultural produce, post-harvest treatment of horticultural crops, Packaging studies in fruits, vegetables and cut flowers by using different packaging materials, methods of storage, post-harvest disorders in horticultural produce. Identification of storage pests and diseases in spices. Visit to markets, packaging houses and cold storage units.

Suggested Readings:

1. **S. Saraswathy, T.L. Preethi, S. Balasubramanyan, J. Suresh, N. Revathy & S. Natarajan**. Post Harvest Management of Horticultural Crops, Agribios (India), Jodhpur.
2. **S. K. Mitra.** Post Harvest Physiology and storage of tropical and subtropical fruits, CABI Publishing.
3. **A.K. Thompson**. Post Harvest Technology of fruits and vegetables, Blackwell Science.
4. **Er. B. Pantastico**. Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables, AVI Publishing Company, Inc.
5. **R.B.H. Wills, W.B. McGlasson, D. Graham, T.H. Lee and E.G. Hall.** Post Harvest: An Introduction to the Physiology and Handling of Fruits and vegetables, CBS Publishers and Distributors, New Delhi.

HORT-528 LANDSCAPE AND ORNAMENTAL GARDENING 3(2+1)

Theory:

Principles of Landscape gardening. styles of gardens; Type of gardens (Hindu, Budhist, Persian, Mughals, Japanese and English gardens), features of garden-paths, roads, edges, lawns, fountains, arches, pergola, shrubbery, topiary, flower beds, hedges, flowering and avenue trees, rockery, conservatory, glass and green house, hanging pots, bird baths, etc. Principles and practices of landscape designs for home gardens and public parks. Study and uses of plant materials and other components in combination for landscape effects. Landscaping of places like cities, towns, countryside, different roads, railway tracks, religious places, industrial areas, offices, hotels, riverside, multistoried buildings with emphasis on terrace garden etc., interior decoration of hotels and buildings. Preparation and maintenance of Bonsai, Rock garden, Water garden and Desert Garden.

Practical:

Identification of ornamental and foliage trees, shrubs, creepers, seasonal annuals and indoor plants. Layout of bungalow garden. Planning and layout of college, school, hotel gardens. Planning layout of a formal garden. Planning and layout of a Japanese garden. Preparation and layout of rockery. Collection of various ornamental plants for herbarium. Planning and layout of a herbaceous border. Pruning and training of hedge. Visit to various public gardens.

Suggested reading

Gopalaswamienger, K.S. (199) Complete gardening in India. Gopalaswami Parthasarthy Shrinivasa, 237/46, Fifth road, Bangalore (India).

Randhawa, G.S. and Jain, R.K. (1973) Ornamental Horticulture. Today and Tomorrow Printers and Publishers, 22-B/5, Original Road, Karol Bagh, New Delhii110005.

Percylancaster, S. (1982) Gardening in India. Oxford & IBH Publishing Co., New Delhi.

Bhanu L. and Desai (1979) Planning and Planting Designs of Home Garden. lCAR, NeW Delhi

Bose, T.K.: Pal, P.; Chowdhury, B. and Sharma, S.P. (2004) Garden Plants in Colour House Plants. Naya Udyog, 206, Bidhan Sarani, Kolkata - 700006.

Bhattachrjee, S.K. (2005) Landscape gardening and Design with Plants. PointeI Publishers, vyas Building, SMS Highway, Jaipur - 302003.

Bhattacharjee, S.K. (2006) Advances in Ornamental Horticulture Vol. I to VI. Ponter Publishiers, Vyas Building, SMS Highway, Jaipur - 302003.

HORTI - 529 PRODUCTION TECHNOLOGY FOR LOOSE FLOWERS (2+ 1)

Theory

UNIT I

Scope of loose flower trade, Significance in the domestic market/export. Varietal wealth and diversity, propagation, sexual and asexual propagation methods, propagation in mist chambers, nursery management, pro-tray nursery under shade nets, transplanting techniques

UNIT II

Soil and climate requirements, field preparation, systems of planting, precision farming techniques.

UNIT III

Water and nutrient management, weed management, rationing, training and pruning, pinching and disbudding, special horticultural practices, use of growth regulators, physiological disorders and remedies, IPM and 1DM.

UNIT IV

Flower forcing and year round flowering, production for special occasions through physiological interventions, chemical regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling and grading, pre-cooling, packing and storage, value addition, concrete and essential oil extraction, transportation and marketing, export potential, institutional support, Flori- Export Zones.

Crops: Jasmine, scented rose, chrysanthemum, marigold, tuberose, crossandra, nerium, hibiscus, barleria, celosia, gomphrena, non-traditional flowers (Nyctanthes, Tabemaemontana, ixora, lotus, lilies, tecoma, champaka, pandanus).

PRACTICAL

Botanical description of species and 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, storage and cold chain, project preparation for regionally important commercial loose flowers, visits to fields, essential oil extraction units and markets.

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.

HORT- 531 PRINCIPLES OF POST HARVEST TECHNOLOGY OF HORTICULTURAL CROPS (2+1)

Theory:

History, present status, importance and scope of post harvest technology of horticultural crops. Maturity indices, pre- harvest factors affecting quality of fruits, changes during fruit growth, transpiration, respiration, physiology and biochemistry of fruit ripening, ethylene evolution and its management. Factors for deterioration of fresh and processed horticultural produce. Food pipe line, post harvest handling of fresh horticultural produce including harvesting, pre-cooling, sorting, grading, pre- treatments, storage, packaging, and distribution. Principles and methods of food preservation, preservation by thermal processing, canning, freezing, dehydration, preservation by sugar, salt, fermentation, radiation, chemical preservatives, antibiotics, etc. Disposal and Utilization of waste from fruit and vegetable processing industry, plant sanitation & Food safety standards. Drying of cut flowers.

Practical:

Analyzing maturity stages of commercially important horticultural crops, physiological loss in weight of fruits and vegetables, estimation of transpiration, respiration rate, ethylene release, study of vase life extension of cut flowers by chemicals, visit to pack house to study post harvest handling practices in fresh fruits and vegetables, preservation by sugar (preparation of jam, jelly etc.), salt (pickles), dehydration, fermentation, tomato processing, visit to fruit and vegetable processing industry.

1. **Er. B. Pantastico**. Post Harvest Physiology, Handling and Utilization of Tropical and Subtropical Fruits and Vegetables, AVI Publishing Company, Inc.
2. **R.B.H. Wills, W.B. McGlasson, D. Graham, T.H. Lee and E.G. Hall.** Post Harvest: An Introduction to the Physiology and Handling of Fruits and vegetables, CBS Publishers and Distributors, New Delhi.
3. **S. Saraswathy, T.L. Preethi, S. Balasubramanyan, J. Suresh, N. Revathy & S. Natarajan**. Post Harvest Management of Horticultural Crops, Agribios (India), Jodhpur.
4. **R.P. Srivastava & Sanjeev Kumar.** Fruit & Vegetable Preservation: Principles and Practices, 3rd Edition, International Book Distributing Co., Lucknow.
5. **Cruess, W.V.** Commercial fruit and vegetable products. Mc Graw Hill Book Co. Inc, New York.

HORT-532 GROWTH AND DEVELOPMENT OF HORTICULTURAL CROPS 2+1

Objective

To develop understanding of growth and development of horticultural crops which have implications in their management.

Theory

UNIT I

Growth and development- definition, parameters of growth and development, growth dynamics, morphogenesis.

UNIT II

Annual, semi-perennial and perennial horticultural crops, environmental impact on growth and development, effect of light, photosynthesis and photoperiodism vernalisation, effect of temperature, heat units, thermoperiodism.

UNIT III

Assimilate partitioning during growth and development, influence of water and mineral nutrition during growth and development, biosynthesis of auxins, gibberellins, cytokinins, abscissic acid, ethylene, brasssinosteroids, growth inhibitors, morphactins, role and uses of plant growth promoters and inhibitors.

UNIT IV

Developmental physiology and biochemistry during dormancy, bud break, juvenility, vegetative to reproductive interphase, flowering, pollination, fertilization and fruit set, fruit drop, fruit growth, ripening and seed development.

UNIT V

Growth and developmental process during stress - manipulation of growth and development, impact of pruning and training, chemical manipulations in horticultural crops, molecular and genetic approaches in plant growth development.

Practical

Physical and Chemical methods to overcome seed dormancy. Germination and viability tests of seed. Visit to arid, subtropical and temperate horticultural zones to identify growth and development patterns, techniques of growth analysis, evaluation of photosynthetic efficiency under different environments, study of growth regulator functions, understanding ripening phenomenon in fruits and vegetables, study of impact of physical manipulations on growth and development, study of chemical manipulations on growth and development, understanding stress impact on growth and development.

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. Mc Graw-Hill.

Peter KV. 2008. (Ed.) *Basics of Horticulture*. New India Publ. Agency.

HORT 533 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, polyploidy 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, pomegranate and ber
UNIT IV: Mangosteen, litchi, jamun, phalsa, mulberry, datepalm, bael and nuts
UNIT V**:** Apple, pear, plums, peach, apricot and strawberry

Practical

Characterization of germplasm, blossom biology, study of anthesis, estimating fertility status, practices in hybridization, evaluation of biometrical traits and quality traits, creening 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.

HORTI- 534 BREEDING OF FLOWER CROPS AND ORNAMENTAL PLANTS 2+1.

Theory

UNIT-I

Principles- origin, distribution, evolution of varieties, genetic resources and genetic divergence. Patents and Plant Variety Protection in India.

UNIT-II

Genetic inheritance- of flower colour, doubleness, flower size, fragrance and post harvest life.

UNIT-III

Breeding methods suitable for sexually and asexually propagated flower crops and ornamental plants- introduction, selection, domestication, polyploid and mutation breeding for varietal development. Role of heterosis, production of hybrids, male sterility and incompatibility problems. Seed production of flower crops.

UNIT-IV

Breeding constraints and achievements made in commercial flowers: rose, gladioli, chrysanthemum, marigold, tuberose, dahlia, china aster, jasmine, orchids, gerbera, carnation,crossandra, anthurium, heliconia and liliums.

UNIT-V

Breeding constraints and achievements made in ornamental plants- hibiscus, bougainvillea, flowering annuals (zinnia, cosmos, snapdragon, petunia, pansy) and ornamental foliages. Introduction and selection of plants for waterscaping and xeriscaping.

Practical

Description of botanical features: cataloguing of cultivars, varieties and species in flowers. Floral biology, selfing and crossing, evaluation of hybrid progenies, seed production. Induction of mutants through physical and chemical mutagens, induction of polyploidy. Screening of plants for biotic and abiotic stresses and environmental pollution. *In vitro* breeding in flower crops and ornamental plants.

Suggested Readings

Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.
Bose TK & Yadav LP. 1989. Commercial Flowers. Noya Prokash.
Chadha KL & Choudhury B.1992. Ornamental Horticulture in India. ICAR.
Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House.
Chaudhary RC. 1993. Introduction to Plant Breeding. Oxford & IBH.
SinghBD.1990.PlantBreeding.Kalyani.

HORT 535 PROPAGATION AND NURSERY MANAGEMENT FOR FRUIT CROPS 2+1

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

Methods of sexual and asexual propagation. Media and nursery sterilization. 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- 536 PROCESSING AND PRESERVATION OF HORTICULTURAL CROPS (1+2)

Theory:

Principles and guidelines for the establishment of processing unit. Containers, equipment and technologies in canning. Solar drying and dehydration, dehydration equipment, freezing of fruits and vegetables. Juice extractions, clarification and preservation, Preparation of fruit beverages and juice concentrate. Role of sugar and pectin in processed products, preparation of jam, jelly, marmalades, preserve, candy, crystallized fruit. Preservation by salt and vinegar, pickling, chutney and processed products of tomato. Sensory evaluation, quality assurance and storage system for processed products. Preparation of various products from flowers and dehydration techniques. Nutritive value of raw and processed products, plant sanitation and waste disposal. Food laws, quality management approaches viz. HACCP, TQM etc.

Practical:

Equipment used in food processing units. Physico-chemical analysis of fruits and vegetables. Canning of fruits and vegetables, preparation of squash, RTS, cordial, syrup, jam, jelly, marmalade, candies, preserves, chutneys, sauces, pickles (hot and sweet). Dehydration of fruits and vegetables, tomato products, dehydration, refrigeration and freezing, cut out analysis of processed foods. Visit to processing units.

Suggested Readings:

1. **R.P. Srivastava & Sanjeev Kumar.** Fruit & Vegetable Preservation: Principles and Practices, 3rd Edition, International Book Distributing Co., Lucknow.
2. **Girdhari Lal, G.S. Siddappaa and G.L. Tandon.** Preservation of fruits & vegetables, ICAR, New Delhi.
3. **Manoranjan Kalia & Sangita Sood.** Food Preservation and Processing, Kalyani Publishers, Ludhiana.
4. **Cruess, W.V.** Commercial fruit and vegetable products. Mc Graw Hill Book Co. Inc, New York.

HORT- 537 Analytical Techniques for Fresh and processed horticultural produce (2+1)

Theory:

Safety aspects of lab, standardization of NaOH, Textural properties of harvested produce and processed foods, TSS, Sp. Gravity, pH and acidity, Sampling procedure for quantitative analysis, Determination of moisture, Determination of relative water content (RWC), physiological loss in weight (PLW), Basic chromatographic techniques, Importance of ethylene, Quantitative estimation of rate of ethylene evolution by fruits and vegetables, using gas chromatograph (GC), Plant pigments and their role in human diet. Spectrophotometry, non-destructive determination of colour, ascorbic acid, sugars, and starch in food crops, Sensory analysis techniques, Control of test rooms, products and panel.

Practical:

Standardization of NaOH. Determination of Textural properties of harvested produce and processed foods. Estimation of TSS, Sp. Gravity, pH and acidity, moisture content relative water content (RWC), physiological loss in weight (PLW). Estimation of rate of ethylene evolution by fruits and vegetables, Estimation of carotenoids, anthocyanin, chlorophyll etc. Practice of using spectrophotometer, determination of colour, ascorbic acid, sugars, and starch in food crops, sensory evaluation etc.

Suggested Readings:

1. **Ranganna, S.** (1997). Handbook of Analysis and quality control for fruits and vegetable products, Second Edittion, Tata McGraw HillPublishing Company Ltd., New Delhi.
2. **Sadasivam, S. and Manickam, A.** (1996). Biochemical Methods, Second Edition, New Age International Publishers, New Delhi.
3. **Thimmaiah, S.**R. (1999). Standard methods of biochemical Analysis. Kalyani Publishers, Ludhiana.

HORT- 538 SEED PRODUCTION TECHNOLOGY OF VEGETABLE CROPS 2+1

Objective

To educate principles and methods of quality seed and planting material production in vegetable crops.

Theory

UNIT I- Definition of seed and its quality, new seed policies; DUS test, scope of vegetable seed industry in India.

UNIT II- Genetical and agronomical principles of seed production; methods of seed production; use of growth regulators and chemicals in vegetable seed production; floral biology, pollination, breeding behaviour, seed development and maturation; methods of hybrid seed production.

UNIT III- Categories of seed; maintenance of nucleus, foundation and certified seed; seed certification, seed standards; seed act and law enforcement, plant quarantine and quality control.

UNIT VI- Physiological maturity, seed harvesting, extraction, curing, drying, grading, seed processing, seed coating and pelleting, packaging (containers/packets), storage and cryopreservation of seeds, synthetic seed technology.

UNIT V- Agro-techniques for seed production in solanaceous vegetables, cucurbits, leguminous vegetables, cole crops, bulb crops, leafy vegetables, okra, vegetatively propagated vegetables.

Practical

Seed sampling, seed testing (genetic purity, seed viability, seedling vigour, physical purity) and seed health testing; testing, releasing and notification procedures of varieties; floral biology; rouging of off-type; methods of hybrid seed production in important vegetable and spice crops; seed extraction echniques; handling of seed processing and seed testing equipments; seed sampling; testing of vegetable seeds for seed purity, germination, vigour and health; visit to seed processing units, seed testing laboratory and seed production farms.

Suggested Readings

Agrawal PK & Dadlani M. (Eds.). 1992. *Techniques in Seed Science and Technology*. South Asian Publ.

Agrawal RL. (Ed.). 1997. *Seed Technology*. Oxford & IBH.

Bendell PE. (Ed.). 1998. *Seed Science and Technology: Indian Forestry Species*. Allied Publ.

Fageria MS, Arya PS & Choudhary AK. 2000. *Vegetable Crops: Breeding and Seed Production*. Vol. I. Kalyani.

George RAT. 1999. *Vegetable Seed Production*. 2nd Ed. CABI.

Kumar JC & Dhaliwal MS. 1990. *Techniques of Developing Hybrids in Vegetable Crops*. Agro Botanical Publ.

More TA, Kale PB & Khule BW. 1996. *Vegetable Seed production Technology*. Maharashtra State Seed Corp.

Rajan S & Baby L Markose. 2007. *Propagation of Horticultural Crops*.New India Publ. Agency.

Singh NP, Singh DK, Singh YK & Kumar V. 2006. *Vegetable Seed Production Technology*. International Book Distributing Co.

Singh SP. 2001. *Seed Production of Commercial Vegetables*. Agrotech Publ. Academy.

HORT-539 PRODUCTION TECHNOLOGY OF UNDEREXPLOITED VEGETABLE CROPS 2+1

Objective

To educate production technology of underutilized vegetable crops.

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- Asparagus, artichoke and leek

UNIT II- Brussels's sprout, Chinese cabbage, broccoli, kale and artichoke.

UNIT III- Amaranth, celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods) and chekurmanis.

UNIT IV- Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean.

UNIT V- Sweet gourd, spine gourd, pointed gourd, Oriental pickling melon and little gourd (kundru).

Practical

Identification of seeds; botanical description of plants; layout and planting; cultural practices; short-term experiments of underexploited vegetables.

Suggested Readings

Bhat KL. 2001. *Minor Vegetables - Untapped Potential*. Kalyani.

lndira P & Peter KV. 1984. *Unexploited Tropical Vegetables*. Kerala Agricultural University, Kerala.

Peter KV. (Ed.). 2007-08. *Underutilized and Underexploited Horticultural Crops*. Vols. I-IV. New India Publ. Agency.

Rubatzky VE & Yamaguchi M. (Eds.). 1997. *World Vegetables:Principles, Production and Nutritive Values*. Chapman & Hall

Srivastava U, Mahajan RK, Gangopadyay KK, Singh M & Dhillon BS.2001. *Minimal Descriptors of Agri-Horticultural Crops*. Part-II: *Vegetable Crops*. NBPGR, New Delhi.

HORTI - 541 PROTECTED FLORICULTURE 3(2 + 1)

Theory

UNIT I

Prospects of protected floriculture in India; Types of protected structures, Greenhouses, polyhouses, shade houses, rain shelters etc., Designing and erection of protected structures; Low cost/Medium cost/High cost structures - economics of cultivation; Location specific designs; Structural components; Suitable flower crops for protected cultivation.

UNIT II

Environment control- management and manipulation of temperature, light, humidity, air and CO2; Heating and cooling systems, ventilation, naturally ventilated greenhouses, fan and pad cooled greenhouses, light regulation.

UNIT III

Containers and substrates, soil decontamination, layout of drip and fertigation system, water and nutrient management, weed management, physiological disorders, IPM and 1DM.

UNIT IV

Crop regulation by chemical methods and special horticultural practices (pinching, disbudding, deshooting, deblossoming, etc.); Staking and netting, Photoperiod regulation.

UNIT V

Harvest indices, harvesting techniques, post-harvest handling techniques, Precooling, sorting, grading, packing, storage, quality standards.

Practical

Study of various protected structures, practices in design, layout and erection of different types of structures, practices in preparatory operations, soil decontamination techniques, practices in environmental control systems, practices in drip and fertigation techniques, special horticultural practices, determination of harvest indices and harvesting methods, post harvest handling, packing methods, project preparation, visit to commercial greenhouses.

Suggested Readings

Bhattacharjee SK. 2006. Advances in Ornamental Horticulture. Vols. I-VI. Pointer Publ.

Bose TK & Yadav LP. 1989. Commercial Flowers. Naya Prokash.

Bose TK, Maiti RO, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya prokash.

Chadha KL. 1995. Advances in Horticulture. Vol. XII. Malhotra Publ. House.

Lauria A & V ictor HR. 200 I. Floriculture - Fundamentals and Practices. Agrobios.

Nelson PV. 1978. Green House Operation and Management. Reston Publ. Co.

Prasad S & Kumar U. 2003. Commercial Floriculture. Agrobios

Reddy S, Janakiram B, Balaji T, Kulkarni S & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

STAT-511 STATISTICAL METHODS 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, the 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.

Practical:

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 'N' 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. Problems based on area tables of normal distribution, Standard normal deviate tests for testing (i) $\mu = \mu_0$ (ii) $\mu_1 = \mu_2$. 't'-test for testing (i) (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) $Y = a+b_1x_1+b_1x_2$. Partial correlation coefficients and tests of significance. Multiple correlation coefficients 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 (1983). Statistics for Agricultural Science. Oxford and IBH, New Delhi.
6. S.C: Gupta (2006). Fundamentals of Statistics. Himalaya Publishing House. New Delhi

STAT- 521 DESIGN OF EXPERIMENTS 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. Design and analysis of C.*R.D.* R.B.D. and L.S.D. with one observation per cell. 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.

Practical:

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. V.G. Panse and P.V. Sukhatme (1985). Statistical Methods for Agricultural Workers. ICAR, New Delhi.
2. Das, M.N. and Giri. N.C. (1986). Design and analysis of Experiments. New Age International Publishers.
3. Chandel, S.R.S. (2004).A Handbook of Agricultural Statistics. Achal Prakashan Mandir, Kanpur.
4. Gomez, K.A. and Gomez , A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons.
5. Agrawal, B.L. (1996). Programmed Statistics. New Age International Publishers.

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.

Gorden H & Rubsell S. 1960. *Hormones and Cell Culture*. AB Book Publ.

Keshavachandran R & Peter KV. 2008. *Plant Biotechnology: Tissue Culture and Gene Transfer*.Orient & Longman (Universal Press).

Keshavachandran R, Nazeem PA, Girija D, John PS & Peter KV. 2007.*Recent Trends in Biotechnology of Horticultural Crops*. Vols. I, II. New India Publ. Agency.

Parthasarathy VA, Bose TK, Deka PC, Das P, Mitra SK & Mohanadas S. 2001. *Biotechnology of Horticultural Crops*. Vols. I-III. Naya Prokash.

Pierik RLM. 1987. *In vitro Culture of Higher Plants*. Martinus Nijhoff Publ.

Skoog F & Miller CO. 1957. *Chemical Regulation of Growth and Formation in Plant Tissue Culture in vitro. Symp. Soc. Exp. Biol.*11: 118-131

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.

PGS 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS 0+1

Objective

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

Practical

Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, 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 article.

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

Suggested Readings

Chicago Manual of Style. 14th Ed. 1996. Prentice Hall of India.
Collins' Cobuild English Dictionary. 1995. Harper Collins.
Gordon HM & Walter JA. 1970. *Technical Writing*. 3rd Ed. Holt, Rinehart & Winston.
Hornby AS. 2000. *Comp. Oxford Advanced Learner's Dictionary of Current English*. 6th Ed. Oxford University Press.
James HS. 1994. *Handbook for Technical Writing*. NTC Business Books.
Joseph G. 2000. *MLA Handbook for Writers of Research Papers*. 5th Ed. Affiliated East-West Press.
Mohan K. 2005. *Speaking English Effectively*. MacMillan India.
Richard WS. 1969. *Technical Writing*. Barnes & Noble.
Robert C. (Ed.). 2005. *Spoken English: Flourish Your Language*. Abhishek.
Sethi J & Dhamija PV. 2004. *Course in Phonetics and Spoken English*. 2nd Ed. Prentice Hall of India.
Wren PC & Martin H. 2006. *High School English Grammar and Composition*. S. Chand & Co.

PGS 503 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE

(e-Course) 1+0

Objective

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

Theory

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

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

Suggested Readings

Erbisch FH & Maredia K.1998. *Intellectual Property Rights in Agricultural Biotechnology*. CABI.

Ganguli P. 2001. *Intellectual Property Rights: Unleashing Knowledge Economy*. McGraw-Hill.

Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.

Ministry of Agriculture, Government of India. 2004. *State of Indian Farmer*. Vol. V. *Technology Generation and IPR Issues*. Academic Foundation.

Rothschild M & Scott N. (Ed.). 2003. *Intellectual Property Rights in Animal Breeding and Genetics*. CABI.

Saha R. (Ed.). 2006. *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies*. Daya Publ. House.

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

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

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

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

Objectives

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

Theory

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

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

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

Suggested Readings

Gupta HK. 2003. *Disaster Management*. Indian National Science Academy. Orient Blackswan.

Hodgkinson PE & Stewart M. 1991. *Coping with Catastrophe: A Handbook of Disaster Management*. Routledge.

Sharma VK. 2001. *Disaster Management*. National Centre for Disaster Management, India.