

Department of Forestry

Name of programme Ph.D. in Agroforestry

Courses offer

Group	Number	Title of Course		Credit
Major	1	FOR 601	Quantitative silviculture	3(2+1)
	2	FOR 602	Advances in tree improvement	3(2+1)
	3	FOR 603	Advances in wood and non-wood forest products	3(3+0)
	4	FOR 604	Advances in economic analysis in forestry	2(2+0)
	5	FOR 605	Agroforestry systems and management	2(1+1)
	6	FOR 606	Forestry interventions for environment melioration	2(1+1)
Total				15(11+4)
Seminar	FOR 691	Credit Seminar		2(0+2)
Thesis research	FOR 699	Research		45(0+45)
Minor	1	AF 621	Advances in agroforestry research & management	2(2+0)
	2	AF 622	Productivity of agroforestry system	3(2+1)
	3	AF 624	Advances agroforestry management analysis and water management in Agroforestry	2(1+1)
	4	AF 625	Advances in soil management	3(2+1)
Total				10(7+3)
Supporting	1	FOR 611	Operational research in forest management	2(1+1)
	2	FOR 612	Land use planning and watershed management	2(2+0)
	3	FOR 613	Forest ecological modeling	2(1+1)
	4	FOR 614	Advances in forest biometrics	2(1+1)
	5	FOR 615	Climate change and forestry	2(2+0)
	6	FOR 616	Information technology in forestry	2(1+1)
Total				12 (8+4)
Non-Credit Compulsory Course	1.	PGS 501	Library and Information Services	1(0+1)
	2.	PGS 502	Technical Writing and Communications Skills	1(0+1)
	3.	PGS 503	Intellectual Property and its Management in Agriculture	1(1+0)
	4	PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)
	5	PGS 505	Agri Res. Ethics and Rural Dev. Programs	1(1+0)
	6	PGS 506	Disaster Management	1(1+0)
	7	HVE	Human value and Professional Ethics	2(1+1)
Total				8(4+4)
Grand total				92(29+63)

Department of Forestry

Name of programme **Ph.D. in Agroforestry**

Minimum credit requirements

Subject	Master
Major	15
Minor	10
Supporting	12
Seminar	02
Thesis research	45
Total	84

Name of programme Ph.D. in Agroforestry

Semester wise course distribution

Course	Course Title	Code	Credit
Semester I			
Major	Quantitative Silviculture	FOR-601	3(2+1)
	Advances in Wood & Non Wood Forest Products	FOR-603	3(3+0)
	Agroforestry System & Management	FOR-605	2(1+1)
Supporting	Operational Research in Forest Management	FOR-611	3(2+1)
	Land Use Planning & Watershed Management	FOR-612	2(2+0)
Compulsory NC	Library Information Services	PGS 501	1(0+1)
	Intellectual Property Rights and its management	PGS 503	1(1+0)
	Basic concepts in Laboratory Techniques	PGS 504	1(0+1)
	Human Value and Professional Ethics	HVE	2(1+1)
Semester II			
Major	Advances in Tree Improvement	FOR-602	3(2+1)
	Forest Intervention for Environment Amelioration	FOR-606	2(1+1)
	Advances in Economic Analysis in Forestry	FOR-604	2(2+0)
Supporting	Forest Ecological Modeling	FOR-613	2(1+1)
	Information Technology in Forestry	FOR-616	2(1+1)
Compulsory NC	Technical Writing and Communication Skill	PGS 502	1(0+1)
	Agricultural Research Ethics and Rural Development Programme	PGS 505	1(1+0)
	Disaster Management	PGS 506	1(1+0)
Semester III			
Minor	Productivity of Agroforestry System	AF-622	3(2+1)
	Advances in Agroforestry Research & Management	AF-621	2(2+0)
	Advances in Forest Soil Management	AF-625	3(2+1)
Supporting	Advance Agroforestry Management Analysis	AF-624	2(1+1)
	Advances in Forest Biometrics	FOR-614	2(1+1)
	Climate Change & Forestry	FOR-615	2(1+1)
	Doctoral Thesis	FOR-699	10 (0+10)
Semester IV			
	<i>Written Comprehensive Examination</i>		
	Doctoral Thesis	FOR-699	10 (0+10)
	Doctoral Seminar First	FOR-691	1(1+0)
Semester V			
	Doctoral Thesis	FOR-699	10 (0+10)
	Doctoral Seminar Second	FOR-692	1(1+0)
Semester VI			
	Doctoral Thesis	FOR-699	15 (0+15)

FOR 601 **Quantitative Silviculture** **2+1**

Objective

To assess growth functions, dynamics of even aged and uneven aged forest. Thinning and growth, self thinning rule or $3/2$ power law of self thinning.

Theory

UNIT I

Growth functions-empirical, exponential, allometry and Backman's growth function. Growth pattern and growth increment curve. Growth cycle and phases.

UNIT II

Correlation between size and plant population. Probability of individual tree mortality. Models of mortality and yield for unthinned forest stands.

UNIT III

Dynamics of even aged and uneven aged forests. Competition for space, light and nutrients in forest stands and their effect on population. Effect of thinning and growth. Plant geometry and self thinning. Stand structure and allometry of trees during self thinning of pure stand. Interpretation of self thinning rule. Detailed concept $3/2$ power law of self thinning and its revaluation and modifications.

Practical

Growth characteristics and effect of temperature, nutrients and water stress on growth behaviour of nursery plants. Preparation of growth and increment curves.

Suggested Readings

- Dwivedi AP. 1993. Forestry in India. Surya Publ.
Evans J. 1982. Plantation Forestry in the Tropics. Clarendon Press.
Kumar V. 1999. Nursery and Plantation Practices in Forestry. Scientific Publ.
Luna RK. 1989. Plantation Forestry in India. Intemational Book Distributors.
Ram Prakash, Chaudhari DC & Negi SS. 1998. Plantation and Nursery Techniques of Forest Trees. International Book Distributors.

Objective

To develop understanding of students in application of mendelian, principles to forest trees and integration of physiological and molecular techniques for tree improvement programmes.

Theory

UNIT I

Mendelian concepts as applied to forest trees. Cytological and chromosomal systems of forest trees. Cytoplasmic inheritance in trees. Colchiploid and mutation breeding for forest trees.

UNIT II

Physiological basis of tree improvement. Pollution responses of trees. Pollen handling and hybridization techniques in forest trees. Tissue culture of trees.

UNIT III

Molecular genetics as applied to forest trees, recent trends in tree improvement, somatic hybrids, transformation, gene sequencing. Inheritance of monoterpene composition in conifers.

UNIT IV

Indirect selection for improvement of desired traits, molecular markers. Juvenile traits and their role in genetic evaluation in tree improvement programmes.

UNIT V

Geographic variation in trees, evolution and gene flow. Exploration and conservation of gene resources of trees. Dioecism and monoecism in trees.

Practical

Cytology of pine root tips, karyotypic analysis, mutagenic treatments with colchicine and MH, tissue culture of organs, and transformation experiments, resin tapping and observation of trees for monoecium and dioecium.

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.

FOR 603 Advances in Wood and Non-Wood Forest Products 3+0

Objective

To acquaint the students regarding updated and advance technology of timber mechanics, wood derivatives, import and export potential of non timber forest produce and latest computer application in forest produces.

Theory

UNIT I Mechanics of wood and wood composites, Application of orthotropic and non-linear constitutive relations, Laminate theory and failure criterion in the prediction of mechanical properties of solid woods; Wood-polymer, Hybrid composite processing.

UNIT II Principles of industrial wood processes, Products derived from wood by chemical processes and value added wood products, Properties of construction, Wood polymers and surface chemistry, Fundamentals of adhesion and fracture in adhesively bonded wood, Adhesive systems used for wood with emphasis in wood based composites.

UNIT III Methods of extraction, chemistry, processing, import and export potential of gums, resins, tannins, dyes, essential oils, fixed oils, cutch and katha, drugs, spices, poisons, insecticides, pesticides, wild edible fruits etc.

UNIT IV Computer application system in forest products, Use of information technologies to integrate material, quality and market fluctuations.

Suggested Readings

- Anonymous. 1981. Wealth of India. CSIR.
Anonymous. 2007. Year Book of Forest Products. FAO.
Dwivedi AP. 1993. Forestry in India. Surya Publ.
Gamble JS. 2002. A Manual of Indian Timbers. International Book Distr.
Krishnamurthy T. Minor Forest Products of India. Oxford & IBH.
Mehta T. 1981. A Handbook of Forest Utilization. Periodical Expert Book Agency.
Negi SS. 2007. Wood Sciences and Technology. International Book Distr.

FOR 604 Advances in Economic Analysis in Forestry

2+0

Objective

To acquaint the students about the latest analytical methods as applied in production forestry and the environment analysis.

Theory

UNIT I

Use of theoretical frameworks of consumer behaviour, market equilibrium, efficiency of perfect and imperfect competition, game theory, and social welfare functions in decision about optimal utilization of forest resources; Issues and dynamics of domestic and international demand & supply of forestry products

UNIT II

Economic and financial rotations and sensitivity analysis of optimum rotation. Valuation of forestry goods and services. Benefit-cost analysis for forestry investments. National income accounting - issues and methodologies in green accounting.

UNIT III

Environmental pollution as a case of common property management. Policy initiatives for improving the management of common property resources and environmental conservation.

Suggested Readings

- Bamoul WJ & Oates WE. 1975. The Theory of Environmental Policy. Prentice Hall.
- Busby RJN. 1981. Investment Appraisal in Forestry. Forestry Commission 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 Economics – Theory and Application in India. Oxford & IBH.
- Makchau JP & Malcolm LR. 1986. Economics of Tropical Farm Management. Cambridge Univ. Press.
- Nautiyal JC. 1988. Forest Economics - Principles and Applications. Natraj Publ.
- Sharma LC. 1980. Forest Economics – Principles and Applications. Natraj Publ.
- Upton M. 1976. Agricultural Production and Resource Use. Oxford Univ. Press.

FOR 605 Agroforestry Systems and Management 1+1

Objective

To impart knowledge on recent development on agroforestry models and its economics.

Theory

UNIT I

Rationale for research proposals: live fences, boundary plantings, hedgerow intercropping, mixed intercropping, fodder banks, woodlots; Possible experimental designs

UNIT II

The use of economics in diagnosis and design of Agroforestry systems; Costs and benefits in Agroforestry; Valuation of inputs and outputs; Environmental outputs

UNIT III

Discounting rates for private and public economic analysis; Discounted measures of economic worth; Non-numerical economic analysis; Methodology for the exploration and assessment of multipurpose trees

UNIT IV

General considerations; Collection of MPTs; Assessment and choice of experimental sites; Assessment of methodologies; Changes in plant species; Tree/crop interface approach; Systematic designs; Bivariate analysis for intercropping experiments; Modelling in Agroforestry; Elements.

Practical

- Developing formats for diagnosis and design investigations; Discussion on published cases of discounting in Agroforestry; Valuation of input and output; Case study on B C ratios for community forestry; Scoring for multiple use of different species; Listing a hundred species of tropical origin; Market trends in tree based products; Study of impact of agroforestry/social forestry on wildlife; Birds and small animals; General of ergonomic data from Agroforestry practitioners in farmlands; Farmers responses to Agroforestry/community forestry; Studies on light and shade effects of trees on understorey plants. A review; The role of voluntary agencies/industries in promoting afforestation programmes; The impact of training to farmers, agricultural officers and others in promoting Agroforestry; Experience of Birsa Agricultural University. Constraints in adoption of Agroforestry; Farmers view point; Visit to agave & biofuel plantations and report on its management practices; Industry; Farmer nexus; Wasteland development; Fuel wood plantations, Biomass productivity assessment; Develop models for rehabilitation of saline and alkaline areas.

Suggested Readings

- Chandawak BS & Gautam SK. 1993. A Textbook of Agroforestry. Oxford & IBH.
Dwivedi AP. 1992. Agroforestry – Principles and Practices. Oxford & IBH.
Huxley P. 1999. Tropical Agroforestry. Blackwell.
Jeffers JNR. 1978. An Introduction to System Analysis with Ecological Application. Edward Arnold.
Jha LK. 1995. Advances in Agroforestry. APH Publ.
Nair PKR. 1993. An Introduction to Agroforestry. Kluwer.
Singh PO, Pathak PS & Roy MM. 1994. Agroforestry Systems for Sustainable Land Use. Oxford & IBH.
Tejwani KG. 1994. Agroforestry in India. Oxford & IBH.

FOR 606	Forestry Interventions For Environment Amelioration	1+1
Objective	To develop understanding of students about environmental sustainability and forestry interventions for environment amelioration	
Theory		
UNIT I	Environmental amelioration- concept and challenges. Integration of environmental conservation strategies and economic development.	
UNIT II	Forestry interventions viz. Plantation forestry, industrial forestry, urban forestry, fuelwood/energy forestry including biofuels, short rotation forestry, Agroforestry, biodiversity parks, Sanctuaries and national parks and catchment plantations.	
UNIT III	Impact of soil erosion, soil moisture regimes, fertility improvements, poverty alleviation, micro-environment native biodiversity and overall environmental sustainability.	
UNIT IV	Environmental concerns, monitoring methods, health & safety, environmental training, environmental organization.	
Practical	Study structures and functions of forestry interventions. Analysis of the micro-environmental attributes viz. temperature, humidity, solar radiations, soil erosion, in-situ measurement of sediment load in native water bodies, native fauna and flora, measurement of particulate air pollutants and other gases.	
Suggested Readings		
	Bamoul WJ & Oates WE. 1975. The Theory of Environmental Policy. Prentice Hall.	
	Busby RJN. 1981. Investment Appraisal in Forestry. Forestry Commission 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 Economics- Theory and Application in India. Oxford & IBH.	
	Makchau JP & Malcolm LR.1986. Economics of Tropical Farm Management. Cambridge Univ. Press. Nautiyal JC. 1988. Forest Economics - Principles and Applications. Natraj Publ.	
	Sharma LC. 1980. Forest Economics - Principles and Applications. Natraj Publ.	
	Upton M. 1976. Agricultural Production and Resource Use. Oxford Univ. Press.	

Minor courses

AF 621 Advances in Agroforestry Research and Management 2+0

Objective

To teach how to refine the Agroforestry systems' management practices and their integration for developing suitable Agroforestry systems.

Theory

UNIT I Recent trends in Agroforestry research and development. Agroforestry land use systems and their salient features.

UNIT II Study of systems specification, prioritizing potential interventions and technology specifications; space and time related considerations.

UNIT III Introduction to on farm and on station research experiments. Factors affecting biomass production.

UNIT IV Soil-site sustainability and environmental resource sharing. Site-Species compatibility. Competition predation, mutualism, commensalisms. Simulation modeling of Agroforestry systems.

Suggested Readings

- Dwivedi AP. 1992. Agroforestry: Principles and Practices. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. New Vistas in Agroforestry. Kluwer.
Nair PKR. 1993. An Introduction to Agroforestry. Kluwer.
Ong CK & Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.
Young A. 1997. Agroforestry for Soil Management. CABI.

AF 622	Productivity of Agroforestry Systems	2+1
Objective	To acquaint the students with concepts in tree-crop systems productivity, managing the factors of production and sustained yield levels.	
Theory		
UNIT I	Concept of crop productivity. Productivity potential in relation to light, water and nutrients.	
UNIT II	System complementarity, supplementarity, competitiveness, sustainability and management techniques. Tree root architecture, reallocation of resources within the plant system.	
UNIT III	Biological yield and harvest index. Growth and yield functions. Land equivalent ratio. Water use efficiency, photosynthetic efficiency, radiation balance, canopy transmissivity, canopy management, plant geometry and crop yield.	
UNIT IV	Allelopathic effects. Strategies to improve the efficiency and productivity of different land use systems	
Practical	<ul style="list-style-type: none">• Techniques for leaf area index, photosynthetically active radiation, soil moisture and leaf water potential and canopy density measurements.	

Suggested Readings

Dwivedi AP. 1992. Agroforestry: Principles and Practices. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. New Vistas in Agroforestry. Kluwer.
Nair PKR. 1993. An Introduction to Agroforestry. Kluwer.
Ong CK & Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.
Young A. 1997. Agroforestry for Soil Management. CABI.

AF 624	Advanced Agroforestry Management Analyses	1+1
Objective	To expose the students towards advanced tools of management with regard to Agroforestry systems.	
Theory		
UNIT I	Advances in Agroforestry management with emphasis on production, marketing and financial management.	
UNIT II	Farm and other landuse principles and systems under perfect and imperfect knowledge situations. Simulation of Agroforestry situations. Evaluating relative profitability of different Agroforestry systems vis-à-vis other competitive agro-based systems.	
UNIT III	Role of various financing agencies in Agroforestry and critical evaluation of different credit systems with emphasis on Agroforestry.	
UNIT IV	Financial, economic and social accounting of Agroforestry projects. Advances in marketing management of Agroforestry products.	
Practical	<ul style="list-style-type: none">Exercises on developing alternative optimal Agroforestry plans under perfect and imperfect knowledge situations. Socio-economic and financial evaluation of Agroforestry projects.	

Suggested Readings

- Dwivedi AP. 1992. Agroforestry: Principles and Practices. Oxford & IBH.
Nair PKR, Rai MR & Buck LE. 2004. New Vistas in Agroforestry. Kluwer.
Nair PKR. 1993. An Introduction to Agroforestry. Kluwer.
Ong CK & Huxley PK. 1996. Tree Crop Interactions – A Physiological Approach. ICRAF.
Thampan PK. 1993. Trees and Tree Farming. Peekay Tree Crops Development Foundation.
Young A. 1997. Agroforestry for Soil Management. CABI.

AF 625 Advances in Soil And Water Management in Agroforestry 2+1

Objective

To impart knowledge on managing soil nutrients and water in Agroforestry systems.

Theory

UNIT I

Soils and their management for agroforestry : physical and biochemical properties of major soil groups in different agroclimatic regions; soil erosion and erodibility; Erosion control

UNIT II

Dynamics of nutrient supply in different soils, changes in nutrient content, nutrient losses, nutrient gains and their assessment; Nitrogen fixation in Agroforestry systems; N fixation process; species; rates of N fixation; factors influencing N fixation; Nutrient cycling; comparison of productivity; case studies.

UNIT III

Hydrology of Agroforestry systems : Soil water relations, moisture management and soil plant water cycles; The role of hydrological modelling in agroforestry system management.

UNIT IV

Organic matter: Decomposition and mineralisation: Litter accumulation - litter decomposition, effect of litter on soil; Interpretation of accumulation - decay and mineralisation processes; management of litter and soil organic matter in Agroforestry systems; Soil and tree management for energy plantations and SRF plantations: Water availability; Nutrient supply, uptake and tree growth, constraints on production, nutrient amendments and correction of nutrient deficiency.

UNIT V

Management and long term soil productivity; soil compaction and erosion; Harvest removal and nutrient Budgeting; Harvest effect on water quality, strategies for future management

Practical

- Nutrient budgeting for different plantation systems - Quantification of physical and chemical soil constraints in social and Agroforestry systems - Evolving new strategies for development

Suggested Readings

Ram Prasad. 1988. Technology of Wastelands Development. Associated Publ..

Sadanandan Nambiar EK & Grown AG. (Eds.). 1997. Management of Soil, Nutrients and Water in Tropical Plantation Forests. ACIAR, CSIR and CIFOR, Australia.

Young A. 1997. Agro-Forestry for Soil Management. CABI.

FOR 611	Operational Research in Forest Management	1+1
Objective	To develop knowledge about operation research in forest management through inventory models and simulation technique also.	
Theory		
UNIT I	Case studies in relation of even and uneven aged stands. Project planning.	
UNIT II	Operational research methods for Forest Management.	
UNIT III	Application of programming-linear and dynamic, network analysis, PERT and CPM, inventory models and simulation technique.	
Practical	<ul style="list-style-type: none">• Application of above techniques through a case analysis using forest inventories.	

Suggested Readings

- Dwivedi AP. 1992. Agroforestry: Principles and Practices. Oxford and IBH.
Dwivedi AP. 1993. A Text Book of Silviculture. International Book Distributors, Dehradun.
Dwivedi AP. 1993. Forestry in India. Surya Publ.
Khanna LS. 1996. Principle and Practice of Silviculture. International Book Distributors.
Ram Prakash 1986. Forest Management. International Book Distributors.
Smith DM, Larson BC, Ketty MJ & Ashton PMS. 1997. The Practices of Silviculture-Applied Forest Ecology. John Wiley & Sons.

FOR 613	Forest Ecological Modeling	1+1
Objective	To develop understanding of students in the concepts of modeling techniques in ecology and analysis of different models for population structure.	
Theory		
UNIT I	Systems and Models - Descriptive and explanatory models – Dynamic systems and models - Deterministic and Stochastic models -Usefulness of ecological research using models.	
UNIT II	Growth of biological populations - measurement of growth rate - population growth models - Discrete one species models - Exponential, Mitscherlich, logistic and Gompertz models - Richards Function Properties of models and estimation to biological data. Growth models with time delays - properties and their applications - Two species models - System of two constant coefficient - first order differential equations and their solutions - Predator and Prey models - Lotka-Volterra equations and their qualitative solutions	
UNIT III	Optimization of resources under constraints - Linear and non-linear programming - Formulation and their applications in ecological modeling. Simulation - Elements and basic concepts - Deterministic simulation – state variables, rate variables and drying variables - Feedback models and their solutions - analytic integration and system behaviour in time-dynamic simulation using numerical integration.	
Practical	Computation of growth rates using tools of calculus - problems in discrete models - Fitting of growth models: exponential, Mitscherlich, logistic, Gompertz and Richards function to data and interpretation - Problems in time delay models and predator and prey models - analysis of qualitative solution of Lotka - Volterra equations - Formulation of linear, dynamic and nonlinear programming models in ecology - simulation - problems in numeric integration - identification of state variables, rate variables and drying variables - simulation of dynamic models using numeric integration.	

Suggested Readings

- Braun M, Coleman CS & Drew DA.. 1978. Differential Equation Models. Springer-Verlag.
Causton DR & Venus JC. 1981. The Biometry of Plant Growth. Edward Arnold.
Leffelaar PA. 1993. On System Analysis and Simulation Processes. Kluwer.
Taha HA. 1992. Operations Research, An Introduction. Prentice Hall of India.

FOR 614	Advances in Forest Biometrics	1+1
Objective	To acquire advance knowledge on estimation of growth of the forest and also study prediction models.	
Theory		
UNIT I	Measurement of tree parameters. Estimation of volume, growth and yield of forest and plantations	
UNIT II	Forest inventory. Sampling methods adopted in forestry. Use of GPS in forest inventory. Various stand density measures. Simulation techniques.	
UNIT III	Different growth and yield prediction models – logistic model, etc. and application	
Practical	<ul style="list-style-type: none">• Calculations of volume of felled as well as standing trees, Vol, Application of sampling procedures, Handling of GPS, calculation of data for prediction of growth models.	

Suggested Readings

Chaturvedi AN & Khanna LS. 1994. Forest Mensuration. International Book Distributor.

Ram Parkash 1983. Forest Surveying. International Book Distr.

Sharpe GW, Hendee CW & Sharpe WE. 1986. Introduction to Forestry. McGraw-Hill.

Simmons CE. 1980. A Manual of Forest Mensuration. Bishen Singh Mahender Pal Singh, Dehradun.

FOR 615 Climate Change and Forestry

2+0

Objective

To acquaint the students about processes causing climate change and ecological and economic impacts and also strategies to combat climate change.

Theory

UNIT I

Introduction to changes in the earth's climate. Definition of climate change – Scientific evidence, process and consequences for society and ecosystems – Interpretation of past climatic conditions from proxy records – Patterns of climate variability – Trends recorded instrumentally – Synopsis of observations

UNIT II

Processes that cause climate change. An overview of mechanisms – Atmosphere – Climate change and thermohaline circulation – Global warming as a possible trigger for climate change – Limited predictability close to an instability – Changes in natural modes of the atmosphere-ocean system – Possible future changes in the hydrological cycle – Ice sheet changes

UNIT III

Economic and Ecological impacts of climate change. Recent scientific studies in the ecological and social sciences – sectoral approaches – Modeling the impacts of climate change – Impacts on the Indian agricultural sector – Sea-level rise and its effect on coastal resources – Potential impact on Indian water resources

UNIT IV

Climate change and implications for sustainable forest management. Impact of climate change on Indian forest - Adaptation of forest trees to climate change – Potential for adaptation – Evolutionary mechanisms – The challenge of climate change for forest management – Different concepts of adaptation to climate change – Case studies on the management of certain tree species in India

UNIT V

Global and regional strategies to combat climate change. Action around the world – European Union: A review of five national programmes – US climate policy: Factors and constraints – Climate change mitigation in Japan – Climate change mitigation programs in India – Electric power futures in five developing countries.

Suggested Readings

- Claussen E, Cochran VA & Davis DP. 2001. Climate Change: Science, Strategies and Solutions. Pew Centre on Global Climate Change, USA.
- Committee on Abrupt Climate Change. 2002. Abrupt climate change: Inevitable Surprises. National Research Council, Ocean Studies Board, National Academics Press, Washington
- Koskela J, Buck A & Teissier du Cros E. 2007. Climate Change and Forest Genetic Diversity: Implications for Sustainable Forest Management in Europe. 2007. Biodiversity International, Rome, Italy.

FOR 616 Information Technology in Forestry 1+1

Objective

To explore students to use information technology in forest research, management of information systems and database in forestry.

Theory

UNIT I Information and communication technology and the forest sector: History; ecommerce in forestry sector. Remote Sensing and Image Interpretation: Basic concepts, elements of photographic system, principles of photogrammetry, introduction to visual image interpretation.

UNIT II Geographical Information Systems (GIS) and Global Positioning Systems (GPS): Different views (database view, map view, model view) of GIS, geographical positioning systems and their use in forestry. Management information systems: Introduction, databases and data warehouses, decisions support and artificial intelligence, operational management and control in forestry through information systems. Database Management Systems: Introduction and objectives, technical over view, internet technologies.

UNIT III Fundamentals of Forest Statistics: Application of point process methods in Forest Statistics, spatial statistics.

Practical

- Applications of GPS : Data retrieval and Database development.

Suggested Readings

Bergeron BP. 2002. Bioinformatics Computing. Prentice Hall.

Ewens WJ & Grant GR. 2001. Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health). Springer.

Jones NC & Pevzner PA. 2004. An Introduction to Bioinformatics Algorithms. MIT Press.

Krane DE & Raymer ML. 2002. Fundamental Concepts of Bio-informatics. Benjamin / Cummings.

Lesk AM. 2002. Introduction to Bio-informatics. Oxford University Press.

Non-Credit Compulsory Course

PGS 501	Library and Information Services	1(0+1)
Objective	To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.	
Practical	Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; ere sources access methods.	

PGS 504	Basic Concepts in Laboratory Techniques	1(0+1)
Objective	To acquaint the students about the basics of commonly used techniques in laboratory.	
Practical	Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vappets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralization of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath, water bath, oil bath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy	

Suggested Readings

Furr AK. 2000. *CRC Hand Book of Laboratory Safety*. CRC Press.
Gabb MH & Latchem WE. 1968. *A Handbook of Laboratory Solutions*. Chemical Publ. Co.

PGS 505	Agriculture Research, Research Ethics and Rural Development Program's	(e-Course) 1(1+0)
Objective	To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.	
Theory		
UNIT I	History of agriculture in brief; Global agricultural research system need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR) International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.	

- UNIT II** Research ethics research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.
- UNIT III** Concept and connotations of rural development, rural development policies and strategies. Rural development programmes Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

Bhalla GS & Singh G. 2001. Indian Agriculture- Four Decades of Development. Sage Publ.
Punia MS. Manual on International Research and Research Ethics. CCS, Haryana Agricultural University, Hisar.
Rao BSV. 2007. Rural Development Strategies and Role of Institutions- Issues, Innovations and Initiatives.
Singh K.. 1998. Rural Development Principles, Policies and Management. Sage Publ.

PGS 506 Disaster Management (e-Course) 1(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 & Stewart M. 1991. Coping with Catastrophe A Handbook of Disaster Management. Routledge.
Sharma VK. 2001. Disaster Management. National Centre for Disaster Management, India.

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. 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. 2ndEd. Prentice Hall of India.
- Wren PC & Martin H. 2006. High School English Grammar and Composition. S. Chand & Co.

PGS 503 (e-Course) Intellectual Property and Its management in Agriculture 1(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.