Ph.D. Forestry and Biodiversity

Syllabus for course work

Department of Forestry and Biodiversity

Tripura University

Programme Outcome: The programme will enable the student to

PO1: Identify the problems and formulate problems specific Research studies in Forestry and Biodiversity

PO2: Advance scientific understanding of the forests and its Biodiversity and the values associated with its existing resources.

PO3: Understand and practise the concepts of conversation and management for meeting the ambits of sustainability.

PO4: Meet the needs of recent global issues by adopting methodologies at par with modern scientific methods and develop models.

PO5: Fulfil the requirements of the communities through research and extension activities.

Syllabus for Ph.D Course Work in Forestry and biodiversity:

Course name	Credit	Course Code	Title	Content
Paper-1: **Research methodology-1**	4	FRBD101C	Research methodology-I **At the end of the course student will be able to….** **CO1:** gain adequate knowledge and understanding on Formulation of Research **CO2:** Understand the soft skills required in Research **CO3:**Know the different aspects of Research ethics **CO4:** Understand the ways and methods of writing research reports	• **Annexure-I**
Paper-2: **Research methodology-2**	4	FRBD102C	Research methodology-II **CO1:** understand the critics of the research in different fields of Forestry and Biodiversity. **CO2:** develop skills in formulation of experimental design	• Review and critics of published research in the field of forestry and biodiversity, training, fieldwork,

			CO3: update advanced knowledge in field of Forestry and Biodiversity.	communication skill etc.- will be finalized by respective RAC.
Paper-3: **Advance area of research in the subject**	4	FRBD101E	Biodiversity and biotechnology **CO1:**The course gives an idea about biodiversity resource utilization and benefits regeneration from organisms/various ecosystems to fulfill daily human life requirements. **CO2:**The course helps to build the mind setup of the student on how high species diversity is vital for the processes and functions of all ecosystems. **CO3:** Our dependency on biodiversity for clean air, food,Pollination of crops, improvement of genetic diversity in agro-ecosystem, and management of crop plant diseases, all of which are imperative for human standards of living and well-being. **CO4:**Generates knowledge on producing sufficient food for the world, developing renewable fuels, and sustainably managing ecosystems. **CO5:**Forest Biotechnology gives our students a specializedcompetence and skills to recognize, understand and findsolutions to the present challenges of green energy production, natural resource utilization, and sustainable development.	• **Annexure-II**

		FRBD102E	Forest Biology & Tree Physiology **CO1:**The course generates abrief concept about how thephysiological process of plantsare collectively affected orindividuals interact with theenvironment and regulate thedistribution of species on earth. **CO2:**Generate an idea about the growth efficiency of different trees species in a particular environment and factors affecting the length of the growing season of trees. **CO3:** This course creates aconcept of how plantsphysiological processes andenvironmental factors regulateplantssexual/reproductive growth. **CO4:**Seed physiology extends knowledge on managing forest tree species of any landscape.	
		FRBD103E	Silviculture **CO1:** Understand the silvicultural practices and techniques in stand management. **CO2:** Identify the problems in silviculture and Develop solutions **CO3:**Acquire knowledge on patterns and dynamics of forest stands. **CO4:** Develop understanding on the ecological processes affecting forest stands. **CO5:** Acquire knowledge and	

			skills in regeneration of Forest species under different systems of management.	
		FRBD104E	Tree improvement **CO1:** Understand the advanced concepts and methods in Tree Improvement. **CO2:** Acquire knowledge hybridization techniques. **CO3:**Understand the reproductive biology of forest trees. **CO4:** Acquire skills in selection and hybrid development. **CO5:** Understand the problems in breeding Forest trees and ways to improve them.	
		FRBD105E	Forest ecology **CO1:**Understand the ecological aspects in forest management. **CO2:**Understand the advanced topics in forest ecology. **CO3:** Impart in-depth knowledge about recent global environmental issues **CO4:**To understand the potentiality of forest genetic resources. **CO5:**To know the strategies for forest conservation.	
		FRBD106E	Advances in agroforestry **CO1:**Develop the knowledge of	

			recent research and development in agroforestry. **CO2:**Explore the potentiality of agroforestry in land use development. **CO3:** Skill for diagnose the problem and develop the agroforestry design for a specific area. **CO4:**Ability to understand different future aspects of agroforestry systems. **CO5:**To know the strategies for agroforestry management.	
		FRBD107E	Environmental impact assessment **CO1:**Understand the concepts and significance of EIA. **CO2:**Calculate the costs and benefits of EIA. **CO3:** Understand the steps and process involved in EIA **CO4:**Apply Remote Sensing and GIS in EIA formulation and assessment. **CO5:**Understand the new approaches and advancements in EIA	
		FRBD108E	Ecosystem goods services and valuation **CO1:**Understand the ecosystem good and service value concept. **CO2:**Know the processes involved in ecosystem and their maintenance.	

			CO3: Prescribe measures maintaining and regulating the ecosystem. **CO4:**Value the ecosystem services by applying the economic valuation concepts and methods. **CO5:**Apply the different methods in valuing ecosystem goods and services.	
		FRBD109E	Conservation ecology and sustainable development **CO1:**Understand the ecological principles in conservation and development. **CO2:**Know the ecological consequences of development activities. **CO3:** Understand the species and landscape approaches to conservation. **CO4:**Visualize the future challenges in sustainable management of ecosystems. **CO5:**Apply the concepts of conservation science in resource management and outreach.	
Paper-4: **Seminar/Practical/Project & Assignment etc.**	4	FRBD103C	**Seminar/Practical/Project & Assignment etc.** **CO1:** develop skills in research reporting. **CO2:** understand the problem-specific research. **CO3:** develop communication	• To be decided according to need of RAC

			and presentation skills	

Annexure-I

FRBD101C **: Research Methodology-I (Credit-4)**

Unit-1: Basic Computer Application

Basic computer knowledge, Features and application related to presentation of text in suitable format and saving the data for future application. Use of word processing, practical knowledge of MS word to type the script, insert tables, figures and graphs, plotting of graphs in excel, preparation of power point presentations based on the topic of research. Insertion of figures, graphs, charts in presentation. Use of spreadsheet and database software, preparation of scientific poster for presentation, Internet and its application: Email, WWW, Web browsing, acquiring technical skills, drawing inference from data, Cloud computing.

Unit-2: Quantitative method, statistics and its application of computer in statistics

Measure of Central tendency and Dispersion, Probability distribution- Normal, Binominal and Poisson distribution. Parametric and Non-parametric statistic. Confidence level, Errors. Quantitative techniques: Level of Significance, Regression and correlation coefficient. Statistical analysis and fitting of data; Chi-square Test, Association of Attributes t-test, ANOVA, Standard deviation, Coefficient of variation. Open source software for quantitative and statistical analysis.

Unit-3: Research Ethics ad IPR

Environmental impact-Ethical issue-ethical committees- Commercialization- Copy right- Royalty- Intellectual property rights and patent law- Trade Related aspects of Intellectual Property Right- Reproduction of published materials- Plagiarism- Citation and Acknowledgement- Reproducibility and accountability.

Unit- 4: Documentation and scientific writing

Results and conclusions, Preparation of manuscripts for publication of Research paper, presenting a paper in scientific Seminar, Thesis writing. Structure and components of research report, Types of Report: Research paper, thesis, research proposal Research project reports. Pictures and graphs citation style, writing a review paper, Bibliography.

Annexure-II

Following courses are approved under Paper-3: Advance area of research in the subject Forestry and Biodiversity for Ph.D programme:

FRBD101E: Biodiversity and biotechnology (Credit-4)

Biodiversity- definition, levels and types; latitudinal and altitudinal gradients of biodiversity; biodiversity and extinctions; biodiversity conservation strategies. Global approaches to biodiversity conservation: Climate change and biodiversity; international programmes for biodiversity conservation. Biodiversity of Indian subcontinent: Indian initiatives in biodiversity conservation-biodiversity act 2002, national biodiversity strategy and action plan (NBSAP), national biodiversity authority (NBA); biodiversity hotspots, their characteristic flora and fauna; Environment and Development Policies: Land and Agricultural Policies; Forest Policies in India

Biodiversity resources of north-east India: Plant and microbial diversity of north east India; threatened vascular plant species in India; biological invasions; Indigenous approaches to biodiversity conservation. Environmental amelioration – concept and challenges. Integration of environmental conservation strategies and economic development.Forestry interventions viz. Plantation forestry, industrial forestry, urban forestry, fuel wood/energy forestry including biofuels, short rotation forestry, Agroforestry, biodiversity parks, Sanctuaries and national parks and catchment plantations.Impact of soil moisture regimes, fertility improvements, poverty alleviation, micro-environment native biodiversity and overall environmental sustainability.Afforestation programmes and forest conflicts, wildlife and human conflicts, important forest movements; forests and food security, eco-tourism and local development, land use change and forestry; Forest rights, customary rights of people, community
Participation, biodiversity and ethno botany.

Genetic diversity- concept, analysis of karyotype variation, genetic erosion, Techniques to assess genetic diversity- Molecular approaches to assessing genetic diversity, Inventory and monitoring biodiversity, Sampling strategies for genetic diversity assessment, sufficiency of sampling procedures, Neutral allele model and optional allocation of sampling efforts. Effects of sampling on genetics diversity, Factor influencing levels of genetic diversity in woody plant species. Conservation of genetic diversity. Global and local limitation for biodiversity conservation. Introduction to nucleic acids-DNA and RNA as molecules of life, discovery, structural elucidation and functions of DNA, nucleotides and nucleosides; synthesis, transcription and translation of DNA; molecular maps and markers- RAPD, RFLP, AFLP, STS, microsatellites, SCAR, SSCP, SNPs, QTL, ITS, etc.; chloroplast, mitochondrial and plasmid DNA-structure and functions; PCR, gel electrophoresis, blotting techniques, SDS PAGE, DGGE/TGGE, genome sequencing-protein and nucleotides.

Principles and requirements of plant tissue culture-cellular totipotency, callus and multiple shoot induction, micropropagation, protoplast isolation and fusion, cybrids, somaclonal variation, single and suspension cell cultures, somatic embryogenesis and PLBs; meristem culture and virus free plants, haploid production, embryo rescue, artificial seed production and cryopreservation.Principles, tools & techniques in cloning and plant genetic engineering/ recombined DNA technology-vector and enzyme mediated transfer of plant genes, structure and function of Ti and Ri plasmids, reporter genes; direct gene transfer-electroporation, particle bombardment, biolistic gun; genetically modified forest crops-application in improving yield and quality, Nif gene in legume and non-legumes, stress tolerance, herbicide & disease resistance in forest crops.

FRBD102E: Forest Biology & Tree Physiology(Credit-4)

Plant Nutrients

Mineral nutrients- absorption, translocation and utilization of mineral salts, Nitrogen metabolism, Water relation, Transport and translocation of water and solute, Salt and drought tolerance physiology in relation to production of biomass. Transpiration and osmo-regulation in relation to stress physiology.

Plant biochemistry and metabolism

Photosynthesis: Carbon partitioning, light reactions. General concepts. Organization of light-absorbing Mechanisms of electron transport. The carbon reactions. The Calvin-Benson cycle. Inorganic carbon-concentrating mechanisms: the C3, C4 and CAM carbon cycle. The impact of environmental conditions on photosynthesis. Overview of plant respiration. Glycolysis. The citric acid cycle. The oxidative pentose phosphate pathway, mitochondrial electron transport and ATP synthesis. Respiration in intact plants and tissues. Photorespiration.

Growth, development and differentiation

Study of tree structure, growth, development and function, how these are related to the environment and to cultural practices, Factors affecting growth of trees, Phytohormones- Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic Acid, Phytochrome; their mechanism of action, Role of growth harmones in vegetative propagation. Signaling and integration: auxin and GA, Biosynthesis and elicitors: ethylene and ABA

Reproductive Physiology

Physiology of flowering, Pollen Biology, Regulation of sexuality, photoperiodism in trees relating to the growth and regeneration, Vernalisation, Physiology of Embryo growth, Fruit Development and Ripening, Seed physiology – Germination and seed dormancy, The mechanism and regulation of seed dormancy and germination, molecular dissection of seed quality, The biophysical basis of seed longevityBud dormancy, Abscission and senescence.

FRBD103E: Silviculture (Credit-4)

Philosophy of silviculture – Advance reproduction methods and their role in Silviculture, Advance silvicultural practices in rain forest; Tropical forest; Subtropical forest, Temperate forest; Mechanization and role in Silviculture, Analysis of different techniques of silviculture in forest

stand management, Technique for early stand development; Analysis of thinning methods and its impact on wood yield and quality.

Stand protection and health management, Advance silviculture techniques for plantation forestry; Case studies of advance silviculture in India and abroad; Problems in silviculture in tropical, subtropical plantation and their solutions Advances in coppice Silviculture Adjusting silviculture to meet industrial demands – Silviculture in perspective – Problem solving procedure for silviculture – Silviculture in retrospect.

Growth functions, pattern and growth increment curves, Correlation between size and plant population, Dynamics of even aged and uneven aged forests. Competition for space, light and nutrients in forest stands and their effect on population, Management strategies for even aged and uneven aged stands, 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.

Principles and methodologies of Forest regeneration, Ecological basis of natural regeneration techniques, Ecological status of woody plants, Choice of species for various sites, Regeneration sampling pattern and intensity, Factors affecting natural and artificial regeneration - Kinds, extent and quality of sites, Relationship of soil characteristics like nutrient, moisture, structure and physiography with tree growth and site productivity; Site manipulation by physical chemical and biological methods. Regeneration in relation to silvicultural systems, Problems of regeneration in respect of important confiers (Fir, Spruce, Deodar, Chir) and broad leaved species (Sandal, Sal, Teak, *Terminalias*, *Alnus* etc.)

FRBD104E: Tree improvement(Credit-4)

Mendelian concepts as applied to forest trees, Cytological and chromosomal systems of forest trees. Colchiploid and mutation breeding for forest trees. Physiological basis of tree improvement. Pollution responses of trees. Assessment of genetic diversity, gene conservation, breeding populations, taxonomy and phylogenetic studies, Problems in gene and phenotypic frequencies, Models of gene action (one locus, multiple locus), theories of selection, inbreeding, migration, mutation and population drift. Phenological studies in forest trees, Pollen handling and hybridization techniques in forest trees.
Reproductive biology of gymnosperms and angiosperms, Reproduction and population genetic structure, population dynamics. Floral morphology, floral initiation and breeding systems. Flowering manipulation. Reproductive abnormalities. Self-incompatibility. overcoming incompatability. Pollination biology, pollination ecology of tropical and temperate forest tree species, plant-pollination interactions. Pollinator energetic and nectar production, Pollen collection storage, extension, theories of pollen dispersal, mating designs, Emasculation and pollination studies in conifers and broadleaved tree species (dioecious, monoecious and bisexual). Pollen vector analysis.

Studies in hybrid development in forest trees. genetics of heterosis, hybrid embryo rescue and studies in hybrid development in forest trees. Indirect selection for improvement of desired traits, Juvenile traits and their role in genetic evaluation in tree improvement programmes. Geographic

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

Tissue culture of trees. Molecular genetics as applied to forest trees, recent trends in tree improvement, somatic hybrids, transformation, gene sequencing. Isolation of DNA, RNA from forest tree species, isozyme analysis, use of molecular markers and RAPD and RFLPs for clonal identification. Sampling, planning and layout, design analysis, variance allocations (components, genotypic and environmental concepts), heritability, correlations, Discriminate function, D^2 analysis, correlation and path co-efficient analysis; Software's in forest genetic analysis and their interpretations.

FRBD105E: Forest ecology(Credit-4)

Development of forest science and forest ecology, Major forest types of the world, forest types of India with special reference to North East India. Forest ecosystem- structure and function; energy flow, energy budget, productivity- primary productivity, secondary productivity, estimation of productivity. Forest community concepts, Community structure, species composition, dominance, ecological diversity, factor affecting diversity, diversity indices- alpha diversity, beta diversity, community diversity; Ecological succession, concepts of forest succession, examples of succession, concepts of climax.

Advanced topics in forest ecology including forest population, forest productivity on a global scale, ecology of forest landscapes spatial heterogeneity; Hierarchy issues in ecology. Forest dynamics; Nutrient cycling and water relations: Nutrient uptake-nutrient source and requirement, accumulation of nutrients by trees, effects of nutrients on tree growth. Nutrient input accumulation and return- litter fall, rainfall and dryfall, acid precipitation, decomposition of organic matter, N2 cycle output of nutrients, mineral cycling in ecosystem.

Conservation of forest ecosystems& wetland ecosystems.Conservation of natural resources (hotspot areas, wildlife sanctuaries, national parks, biosphere reserve).Green house effect and its consequences.Ozone depletion, Global warming, acid pollution and their effect on forest regeneration and health.Survey exploration and sampling strategies.Site quality evaluation, direct measurement of forest productivity, tree height as a measure of site quality, site index curve, vegetation as an indicator of site quality, species groups and indicator spectra, site classification by habitat types, environmental factors as a measure of site, climatic factors, soil site study, multiple factor methods of site classification.

Documentation and evaluation of Forests Genetic Resources (FGR), in situ and ex situ conservation of gene resources.Biological diversity and its significance to sustainable use.Handling and storage of FGR. Quarantine laws and FGR exchange. Climatic, edaphic, topographic factors and vegetation distribution. Disturbance as an ecosystem process, source of disturbance, major disturbance in forest ecosystem: fire, storm, flood, insect and diseases, logging, land clearing: elimination of spices, addition of species, anthropogenic disturbance, climate change.

FRBD106E: Advances in Agroforestry(Credit-4)

Recent trends in Agroforestry research and development. Agroforestry land use systems and their salient features; Study of systems specification; space and time related considerations. Site-Species compatibility; Simulation modeling of Agroforestry systems.Productivity potential in relation to light, water and nutrients. System complementarity, supplementarity, competitiveness', sustainability and management techniques.Tree root architecture, reallocation of resources within the plant system.

Biological yield and harvest index; Land equivalent ratio; Water use efficiency, photosynthetic efficiency, radiation balance, canopy transmissivity, canopy management, plant geometry and crop yield. Allelopathic effects. Strategies to improve the efficiency and productivity of different land use systems.

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

Financial, economic and social accounting of Agroforestry projects. Advances in marketing management of Agroforestry products.Soils and their management for agroforestry ; Nutrient cycling; comparison of productivity; case studies; Soil water relations, moisture management and soil plant water cycles; The role of hydrological modelling in agroforestry system management.

FRBD107E: Environmental impact assessment(Credit-4)

Introduction; Principles and purposes of IEE and EIA and its significance for the society, Cost and benefits of EIA; EIA involvement during project life cycle. EIA management; Principles and management of EIA, main stages in EIA process; screening, scoping, prediction, mitigation and alternatives auditing. EIA techniques, checklists, matrices, network method, Use of remote sensing and GIS in EIA. Public consultation and participation in EIA process. EIA guidelines and review process. EIA formulation. New approaches to EIA, SIA and SEA (strategic environmental assessment).

FRBD108E: Ecosystem goods services and valuation(Credit-4)

Ecosystem good or service value concepts. Values of bio-resources and biodiversity; tangible and intangible benefits timber, food and fodder yielding species; Non wood forest produce-NWFP-Bamboos, Rattans, Medicinal plants, Orchids. Animal produce- Honey, vermifuse role of litter and compost in nutrient cycling. Linkages of ecosystem process with services. Millennium development and ecosystem goods and services.

Ecosystem Process: Maintenance of Energy flux, dissipation, climate modulation. Maintenance of hydrologic cycle, water quality. Biological productivity, plant pollination. Maintenance of biogeochemical cycling, storage, mineral-gaseous cycles, water-air quality. Decomposition, weathering, soil development-stability, soil quality. Maintenance of biological diversity. Absorbing, buffering, diluting, detoxifying pollutants-xenobiotics.

Ecosystem "goods": food, construction materials, medicinal plants, wild genes for domestic plants and animals, Tourism and recreation.Ecosystem "services" : Maintaining hydrological cycles, Regulating climate, cleansing water and air, Maintaining the gaseous composition of the atmosphere, pollinating crops and other important plants, Generating and maintaining soils, storing cycling essential nutrients, Absorbing and detoxifying pollutants, providing beauty, inspiration, and recreation.

Valuation of ecosystem services: Economic valuation concept and methods used to link ecosystem functions to human values. Identification of potential ecosystems and associated services including water filtration and storage, habitat, carbon and nitrogen sequestration. Dimensions of economic value. Illustration of economic values of ecosystem goods and services. Methods for valuing ecosystem goods and services. Providing and financing ecosystem goods and services conditions of exchange. Examples of methods include using property values and participation in recreation opportunities, as well as surveys to assess individuals' preferences.

FRBD109E: Conservation ecology and sustainable development(Credit-4)

This course emphasizes ecological principles important to conservation and development and the ecological consequences of development activities. Global biodiversity, decline terrestrial biodiversity. Global decline of wildlife population and conservation efforts. Ethics of conservation. Economics of conservation. Habitat degradation and loss of economic values. Over exploitation of renewable resources. Habitat fragmentation. Exotic species invasion. Conservation genetics and extinction process in an ecosystem. Species and landscape approaches to conservation. Future challenges in maintaining unsustainable ecosystem as population sinks for wildlife. Current and future challenges in the environment and population management. Conservation science, resource management, and environmental outreach.