PONDICHERRYUNIVERSITY

School of Life Sciences

DEPARTMENT OF ECOLOGY & ENVIRONMENTAL SCIENCES

CURRICULUM FOR M.Sc. PROGRAM IN ECOLOGY

2023-24 onward

PONDICHERRY UNIVERSITY
School of Life Sciences
Department of Ecology & Environmental Sciences

Master of Science in Ecology

PROGRAM OBJECTIVES

The objectives of the MSc Ecology are:

1. to provide students the fundamental concepts and principles of environment

2. to make students aware of the importance of environment and its conservation

3. to introduce the modern tools and techniques available to study and understand the environment

4. to teach field techniques, sample collection, mapping and analysis

5. to make students to take up research and teaching in environmental sciences

PROGRAM OUTCOME

The students will

1. understand the concepts and principles of environment

2. understand the structural and functional aspects of environment and the need for its conservation

3. Be familiar with modern tools and techniques and their appropriate use to conduct research.

4. Be aware of the suitable use of field techniques, sample collection, mapping, analysis and interpretation.

5. Be able to take up research and teaching in environmental sciences.

ELIGIBILITY

- Bachelor's degree in Science with a minimum of 55% marks.

PONDICHERRY UNIVERSITY
School of Life Sciences
Department of Ecology & Environmental Sciences
Curriculum for
M.Sc. Ecology - 2023-2024 onwards

CODE	NAME OF THE HARDCORE COURSES	CREDIT	PAGE NO.
SEMESTER – I			
ECOL 401	TERRESTRIAL ECOLOGY	4	3
ECOL 402	BIODIVERSITY AND CONSERVATION	4	5
ECOL 403	STATISTICAL ECOLOGY & RESEARCH METHODOLOGY	4	7
ECOL 404	MICROBIAL ECOLOGY	4	9
SEMESTER – II			
ECOL 411	POPULATION AND COMMUNITY ECOLOGY	4	11
ECOL 412	EVOLUTIONARY ECOLOGY	4	13
ECOL 413	AQUATIC ECOLOGY	4	15
SEMESTER – III			
ECOL 501	REMOTE SENSING AND GIS	4	17
ECOL 502	BEHAVIOURAL ECOLOGY	4	19
ECOL 503	ENVIRONMENTAL IMPACT ASSESSMENT	4	20
SEMESTER – IV			
ECOL 599	DISSERTATION PROJECT	12	

Total Credit for Hard Core courses = 52
Total Credit for Soft Core courses = 20
Total Credit requirements = 72

SOFTCORE COURSES – ECOLOGY

CODE	NAME OF THE SOFT CORE COURSES	CREDIT	PAGE NO.
ECOL 461	AGRICULTURE AND WEED ECOLOGY	4	22
ECOL 462	LANDSCAPE ECOLOGY AND PLANNING	4	24
ECOL 463	FORSET BOTANY	4	25
ECOL 464	SCIENCE COMMUNICATION	4	27
ECOL 465	PLANT-ANIMAL INTERACTIONS	4	28
ECOL 466	ORNITHOLOGY	4	29
ECOL 467	BIOLOGICAL INVASIONS	4	30
ECOL 468	FOREST ECOLOGY	4	32
ECOL 469	AGRO ECOSYSTEMS AND AGROFORESTRY	4	34
ECOL 470	FUNDAMENTALS TO ECOLOGY AND ENVIRONMENTAL SCIENCE	4	36
ECOL 471	ECOLOGY OF URBAN ENVIRONMENT	4	38
ECOL 472	MANGROVE ECOSYSTEM	4	39

TERRESTRIAL ECOLOGY

ECOL: 401 **CREDITS: 4**

COURSE OBJECTIVES: To understand the principles of biomes distribution and types, and its biodiversity and functional ecology including their conservation perspectives especially under the climate change scenario.

UNIT-I Climate, climate change scenario and distribution of terrestrial ecosystems; Distribution, climate, soil, biota, community structure and functioning; current status and conservation of certain biomes; Sand dune ecosystem: formation, soil and community structure, zonation in sand dunes and functioning. (**10 Hours**)

UNIT-II Tropical scrubs and thorn forests: distribution, species composition, structure and functioning, effects of plantations and land use change; Tropical dry evergreen forests: Distribution, forest structure, composition, component interactions, human impacts and conservation. (**10 Hours**)

UNIT-III Desert ecosystem: distribution, types, climate, soil, vegetation, animals and adaptation of various biota, human interaction; Savanna woodlands: types of savannas and their distribution, structural and functional characteristics, soils, seasonality, productivity, phenodynamics, phytomass use by animals; Tropical deciduous forests: distribution, seasonality, vegetation, resource use by animals and humans; dry forest status and conservation significance. (1**0 Hours**)

UNIT-IV Tropical rainforests: distribution, climate, stratification, floral-faunal interactions, deforestation; Tundra: Tundra zone, climate and day length, soils and the process of cryoturbation, seasonality in tundra vegetation and faunal resource utilization; Taigas: distribution, climate, vegetation, serotiny, leaf litter accumulation and nutrient pools, fauna. (**10 Hours**)

UNIT-V Temperate broad leaved deciduous forests: distribution, species composition and seasonal changes; Temperate grasslands: distribution, species composition and functional aspects; Temperate broad-leaved Sclerophyll and rainforests, Why sclerophylly? Similarities of tropical and temperate rainforests. (**10 Hours**)

UNIT-VI Assessment of: forest tree, liana diversity, forest biomass and carbon stocks; Plant functional trait analyses: vegetative and reproductive traits; Nutrient cycling in forests – soil and litter sampling and chemical analyses; Assessment of human disturbance for forest conservation and management. (**10 Hours**)

Text Books:

1. Goldstein, M. & D. Dellasala, 2020. Encyclopedia of World's Biomes. Elsevier. 3500p. 5 vols.
2. Sher, A.A & M. C. Molles. Jr. 2022. Ecology: Concepts and Applications, 9th Edition. Mc Graw Hill. ISBN10: 1260722201 | ISBN13: 9781260722208
3. Archibold, O.W. 1995. Ecology of World Vegetation. Chapman & Hall, London.

Reference Books:

Friday, A & D.S. Ingram (Gen. Eds.) 1985. The Cambridge Encyclopedia of Life Sciences, Cambridge Univ. Press, Cambridge.

Ecosystems of the World Series - Nos.1,2,3,4,5,6,7,8,12,13, & 14 Elsevier, Amsterdam.

Singh, J.S., Singh, S.P. & Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand & Company Pvt. Ltd., New Delhi. 929p.

COURSE OUTCOME: Students will know about climate and global distribution of various biomes, their diversity, ecosystem functioning and conservation need.

BIODIVERSITY AND CONSERVATION

ECOL: 402 **CREDITS: 4**

COURSE OBJECTIVES: To gain an understanding of : (1) status of the planet's biological diversity (2) value of biodiversity and drivers of its loss (3) basic concepts and scientific principles of conservation and global patterns in biodiversity (4) current efforts to conserve biodiversity on global, national and regional scales; (5) practical issues with regional conservation.

UNIT–I Biodiversity: Definition, importance**,** magnitude and global accumulation of biodiversity; Diversification through geological time scale; Levels of biodiversity; Species diversity: (i) global tree diversity and distribution pattern (ii) Diversity and ecology of lianas, (iii) Litter arthropods: sampling methods and role in nutrient cycling and (iv) Small mammals in tropical forests: diversity and role in ecosystem functioning. Genetic diversity: measurement of genetic diversity, transgenic organisms; Agro-biodiversity. **(10 Hours)**

UNIT–II Measurements of biodiversity: Species richness & abundances, diversity indices – Shannon, Simpson & Fisher's Alpha, beta diversity; Biodiversity and various ecosystem services; Valuation of ecosystems and species; Biodiversity prospecting and indigenous knowledge systems, community biodiversity registers. Biodiversity as bio resources – use and values (consumptive and productive use values) of biodiversity as sources of food, fodder, timber, medicinal and ornamental plants**.**

(10 Hours)

UNIT-III Threats and loss of biodiversity; Global deforestation rate - extinction crises; Causes for extinction: habitat loss, industrialization, hunting and bio invasions; invasive species; Wiser use & management; Extinction through geological time scale: mass extinction, current extinction trends; The theory of island biogeography; Edge effect; SLOSS. **(10 Hours)**

UNIT-IV Conservation strategies: *In-situ* and *ex-situ* conservation; biodiversity hot spots, hottest hot spots, mega diversity countries, centers of plant diversity and endemism; India: Biospheres, National Parks and Wildlife Sanctuaries, Wildlife conservation projects: Crocodile Conservation, Sea Turtle Conservation. **(10 Hours)**

UNIT-V Overview of conservation efforts: global protected area network; Protected areas and its roles; UNESCO biosphere reserves; IUCN species conservation status categories: crtocally endangered, endangered, vulnerable, near threatened, Red Data Books; Regulation of biodiversity: Convention on Biological Diversity, National Biodiversity Authority, WCMC, CITES, **(10 Hours)**

UNIT-VI Demonstration of biodiversity assessment methods in the University campus; Qualitative and Quantitative analysis of vegetation; Filed visit to the forest nearby or protect area to study the biodiversity assessment and understand the conservation strategies employing the protected area.

(10 Hours)

Text Books

1. Malcolm L. Hunter, Jr., James P. Gibbs, Viorel D. Popescu. **(**2021**)**. Fundamentals of Conservation biology (4th edition). Wiley
2. Fred Van Dyke, Rachel L. Lamb (2020). Conservation Biology: Foundations, Concepts, Applications. Springer International Publishing

3. Anna A. Sher, Richard B. Primack · (2019) an Introduction to Conservation Biology. Oxford University Press
4. Krishnamurthy KV (2018) an Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
5. Singh JS, Singh SP and Gupta SR (2014) Ecology, Environmental Science and Conservation. 4th Edition. S. Chand & Company Pvt. Ltd.
6. Peter Stiling (2015). Ecology: Global Insights & Investigations 2nd Edition. McGraw-Hill international edition

Reference books

7. Petros Ganatsas (2021). Forest Biodiversity, Conservation and Sustainability. Mdpi AG
8. Lisa Idzikowski (2019). Biodiversity and Conservation. Greenhaven Publishing LLC
9. Kelsey Malone (2020) Ecology: Evolution, Biodiversity and Conservation CALLISTO REFERENCE.
10. Michael O'Neal Campbell. 2021. Critical Research Techniques in Animal and Habitat Ecology. Nova Science Publishers.
11. Jase Fitzgerald (2017). Biodiversity: An Introduction. Larsen and Keller Education.
12. Anne E. Magurran, Brian J. McGill (2011) Biological Diversity: Frontiers in Measurement and Assessment. Oxford University Press.

COURSE OUTCOME: At the end of the course the students will (1) cite the scientific evidence for biodiversity change in the modern era and detail the contemporary causes of diversity loss, (2) understand and convey the ecological, social, and economic impacts of diversity loss, and (3) apply management principles and tools that are used to conserve diversity at levels from genes to landscapes.

STATISTICAL ECOLOGY AND RESEARCH METHODOLOGY

ECOL 403 **CREDITS: 4**

COURSE OBJECTIVES: To introduce the statistics for ecological and environmental data analysis.

UNIT-I Basics of scientific research and methodology; framing a scientific question in ecology and review of literature; Formulating the hypothesis and types of hypotheses: null hypothesis and alternate hypothesis; Experimental design and collection of data; Variables- types of variables including discrete and continuous variables; Sample distribution, level of significance, Type-I and Type II errors; Accuracy Vs Precision; Significant figures; Population and sample; Population parameters: Environmental sampling design - sampling locations and times; Different techniques of sampling – simple random, stratified random, systematic sampling and errors in measurement. **(10 Hours)**

UNIT-II Central tendency- concept; arithmetic mean, geometric mean, mode, median for ungrouped and grouped data. Data dispersion and concept of standard deviation. Variance. Standard Deviation Vs Standard error. Probability Rules and Theoretical Distributions: Basic probability rules, expectation, conditional probability; Probability distributions – Binomial, Poisson, Normal distributions. Skewed data and data transformations (log, square root and arcsine). **(10 Hours)**

UNIT-III Parametric and Non-parametric tests; Null hypothesis and uses of t- test, F-test, X^2-tests; Test of significance of large samples; Correlation and Regression: Bi-variate data and scatter diagram; Simple (linear) correlation and regression; Coefficient of correlation and regression and their properties; Fitting of regression line; Multiple and partial correlations and regressions. **(10 Hours)**

UNIT-IV Parametric tests: Student's t test (paired and unpaired t test). Analysis of Variance: Different types of models used in ANOVA; Basic assumptions and its violation; Application of ANOVA to environmental data. Distribution- Normal, t and chi square test; Difference among means: F-test: One-way ANOVA and multiple ANOVA (MANOVA), Posthoc tests (Tukey test). **(10 Hours)**

UNIT-V Non-parametric tests: Wilcoxon test, Mann-Whitney U-test, Kruskal and Wallis test, Friedman test and posthoc tests (Nemenyi test). Computer applications in environmental modeling, Computer based modeling for population and population studies. **(10 Hours)**

UNIT-VI Multivariate data analysis, hypothesis testing Model fitting; Matrices, simultaneous linear equations; tests of hypothesis and significance; Multidimensional Scaling, Principal Component Analysis, Canonical Correspondence Analysis using software like PAST, Statistica, SPSS. **(10 Hours)**

Text books:

1. Zar, Jerrold H. (2018). Biostatistical Analysis. 5th Edition, Pearson Publication.
2. Sokal RR and Rohlf FJ (2009) Introduction to Biostatics, 2nd Edition, Dover Publications, Inc, New York.
3. Walpole, R. and R. Myres (1993). Statistics for Engineers and scientists, 5th edn. Mac Millan, N.Y.
4. Bhujel Ram C. (2011). Statistics for Aquaculture. John Wiley and Sons.

Reference Books:

1. Wayne, R. Ott (1995). Environmental Statistics and Data analysis, CRC Press.

2. Manly (2001) statistics for environmental science and management, Chapman and Hall/CRC Press

COURSE OUTCOME: The students will be able to select appropriate statistical tool and analysis of ecological and environmental data.

MICROBIAL ECOLOGY

ECOL: 404 **CREDITS: 4**

COURSE OBJECTIVES: To introduce the fundamental and applied aspects of microbial ecology

UNIT-I Overview of microbial ecology - research and application; understanding origin of life and evolution; microbial diversity and taxonomy, ecosystem functioning, interactions with biotic and abiotic agents; environmental applications; historical perspective of microbial ecology, discovery of microbes; beginnings, current aspects and future perspective of microbial ecology. **(10 Hours)**

UNIT-II Structure, function and diversity of prokaryotes and eukaryotes - origin, evolution and fossils – endosymbiosis – mechanism and process – tree of life – phylogenetic position of microbes – taxonomy and phylogeny of prokaryotes and eukaryotic microorganisms – life cycles of microorganisms. Microbial habitats – biodiversity and ecosystem functioning. **(10 Hours)**

UNIT-III Microbial interactions in abiotic environments - Acidophiles - Alkaliphiles - Exobiology - Extremophiles - Halophiles - Piezophiles - Psychrophiles - Thermophiles/hyperthermophiles; Microbial ecology and functioning of food webs in aquatic and terrestrial ecosystems – decomposition of organic matter in soils – nutrient cycling. Biogeochemical cycles – carbon, nitrogen, sulfur and phosphorus cycles. **(10 Hours)**

UNIT-IV Microbial interactions in biotic environments; Conflictual interactions – parasitism - predation - antibiosis – competition; Beneficial interactions – cometabolism – mutualism – cooperation – commensalism; Microbial interactions with plants - sources and diversity of microorganisms associated with plants – pathogenic and symbiotic organisms. Interaction of microorganisms, animals and humans – sources and diversity. **(10 Hours)**

UNIT-V Applied microbial ecology; Bioaugmentation - biodegradation - bioimmobilization - bioleaching - bioremediation - biostimulation - hydrocarbons - pesticides - petroleum - pollutants = polychlorobiphenyls - rhizostimulation - solid wastes treatments - wastewater treatments – xenobiotics **(10 Hours)**

UNIT-VI Methods for studying microorganism under different environments - sampling techniques - bacterial isolation - biomarkers - cultural techniques - cytometry - DNA microarray - microbial activities - microelectrodes - molecular fingerprints - PCR - phospholipid fatty acid analyses - pigment analyses - metagenomics. **(10 Hours)**

Text Books:

1. Raghvendra Pratap Singh, Geetanjali Manchanda, Kaushik Bhattacharjee, 2021. **Microbes in Microbial Communities**: Ecological and Applied Perspectives Hovik Panosyan. Singapore: Springer Singapore Pte. Limited.
2. Jay Shankar Singh, Shobhit Raj Vimal **2020. Microbial Services in Restoration Ecology**.. San Diego: Elsevier.
3. Aparna Gunjal, Sonali Shinde **2021. Microbial Diversity and Ecology in Hotspots**. San Diego: Elsevier Science & Technology.
4. Surajit De Mandal, Amrita Kumari Panda, N. Senthil Kumar, Satpal Singh Bisht, Fengliang Jin Milton **2021. Metagenomics and Microbial Ecology: Techniques and Applications**. Taylor & Francis Group; 2021.

Additional references:

1. Suraja Kumar Nayak, Bibhuti Bhusan Mishra. 2020. **Frontiers in Soil and Environmental Microbiology**. Milton: Taylor & Francis Group.
2. Maulin Shah, B.R.M. Vyas. 2023. **Emerging Technologies in Applied and Environmental Microbiology**. San Diego: Elsevier Science & Technology.

COURSE OUTCOME: Students will know the ecology and beneficial aspects of microorganism in bioremediation, food production and their application in biotechnology.

POPULATION AND COMMUNITY ECOLOGY

ECOL: 411 **CREDITS: 4**

COURSE OBJECTIVES: To gain an understanding of: (1) complex patterns and processes in the population and community ecology (2) population growth and dynamics and its regulation (3) Recognise and justify the importance of ecological interactions in shaping the structure of ecological communities

UNIT-I Introduction to population ecology, A review of terms and concepts, attributes of populations, introduction to Mendelian and population genetics, Hardy Weinberg's law, genetic drift, gene flow. **(10 Hours)**

UNIT-II Demographic parameters - Mortality, fecundity and age structure. Life tables – cohorts and static. Population growth: exponential and logistic. Human population growth. Population regulation. Single species populations: intra-specific competition, density dependence. **(10 Hours)**

UNIT-III Community Ecology - Intra-specific competition: Competition exclusion principle and Hutchinson's rule, Gause's theory of niche, coexistence patterns of competing species; Inter-specific competition - Galapagos finches as an example; Predator-prey interactions: Functional responses of predator to prey; co-evolution – Red Queen hypothesis. **(10 Hours)**

UNIT-IV Plant-animal interaction: mutualisms, commensalism and competition. Host-parasite interactions, Life history strategies – r and k selection. Meta population dynamics: Types of Meta populations **-** Levins Meta population, Mainland-island Meta population, **(10 Hours)**

UNIT-V Population fragmentation, Population viability analysis: deterministic and stochastic models. Capture - Recapture sampling (closed populations & open populations) – demography. Community Ecology: species richness patterns – species richness and community services **(10 Hours)**

UNIT – VI Field visit to analyze the population structure of tree species in a given area. Hands-on training to assess the population size by capture and recapture technique -Mini Project – Preparation of co-harts life table - Understand the Self-thinning mechanism. Analyze the density dependents growth pattern and determine the growth and resource allocation patterns in different population sizes in the laboratory conditions. **(10 Hours)**

Text books

1. Royama, T. 2021. Animal Population Ecology An Analytical Approach. Cambridge University Press. ISBN: 9781108844420, 1108844421
2. Brett K. Sandercock, Dennis L. Murray 2020. Population Ecology in Practice. Wiley. ISBN:9780470674147, 0470674148
3. Begon M, Mortimer M, Thompson DJ (2009) Population Ecology: A Unified Study of Animals and Plants, 3rd Edition. Wiley-Blackwell. ISBN: 9781444313758, 1444313754
4. Rockwood LL (2015) Introduction to Population Ecology. Blackwell publishing (2nd Ed.) ISBN: 978-1-4051-3263-3.
5. Peter Stiling (2015). Ecology: Global Insights & Investigations 2nd Edition. McGraw-Hill international edition
6. Gary G. Mittelbach, Brian J. McGill · 2019. Community Ecology Oxford University Press
7. John H. Vandermeer Deborah E. Goldberg (2013) Population Ecology: First Principles (Second Edition). Princeton University Press, ISBN: 978-0691160313.

Reference books

1. Michael Schaub and Marc Kery 2021. Integrated Population Models: Theory and Ecological Applications with R and JAGS. Elsevier Science. ISBN: 9780323908108, 0323908101
2. Michael Begon and Colin R. Townsend 2020 Ecology From Individuals to Ecosystems. Wiley. ISBN:9781119279372, 1119279372
3. Paul A. Keddy, Daniel C. Laughlin · 2021. A Framework for Community Ecology Species Pools, Filters and Traits. Cambridge University Press.ISBN:9781316512609, 1316512606
4. Bruce David Leopold 2019. Theory of Wildlife Population Ecology. Waveland Press, Incorporated. ISBN: 9781478630647, 1478630647
5. Mark Vellend · 2020. The Theory of Ecological Communities (MPB-57).Princeton University Press.ISBN:9780691208992, 0691208999
6. Dick Neal · 2018. Introduction to Population Biology. Cambridge University Press. ISBN:9781107605121, 1107605121
7. Jonathan Silvertown and Deborah Charlesworth 2009. Introduction to Plant Population Biology. Wiley. ISBN: 9781444311150, 1444311158.
8. Hamilton MB (2009) Population Genetics. John Wiley & Sons Ltd, UK.

COURSE OUTCOME: Students will acquire a theoretical understanding of population and community ecology to apply in the current issues in ecology and critically evaluate the value of long term studies of populations and communities. Knowledge and skills to use practical and analytical techniques to examine population size and structure and quantify population dynamics

EVOLUTIONARY ECOLOGY

ECOL: 412 **CREDITS: 4**

COURSE OBJECTIVES: To understand the ecological concepts and evolution of different species and their interactions.

UNIT-I Introduction to Evolutionary Ecology – Types of Evolution; Scaling and the hierarchical structure of biology, levels of approach in biology, domain of ecology, definitions and ground work; anthropocentrism, the importance of wild organisms in pristine natural environments, the urgency of basic ecological research; scientific methodology; models; multiple causality; limiting factors, tolerance limits, the principle of allocation; natural selection, self-replicating molecular assemblages; units of selection. **(10 Hours)**

UNIT-II Nature Selection and Population Structure – Population growth and regulations; factors affecting populations; population "cycles," cause and effect; use of space (vagility, home range, territoriality, foraging tactics); Verhulst-Pearl Logistic equation; evolution of sex; sex ratio; social organization; evolution of mating systems; sexual selection; kin selection, inclusive fitness; reciprocal altruism, parent-off spring conflict. **(10 Hours)**

UNIT-III Evolutionary consequences on the interaction amongst species; Competition and Niche Theory: Lotka-Volterra equations and competition theory; predation and parasitism; diffuse competition; niche overlap and competition; Predation Theory; predator-prey oscillations, predator escape tactics, adaptive coloration, mimicry, warning calls; coevolution - plant-herbivore interactions and plant-appetency theory; parasitism; Darwinian medicine. **(10 Hours)**

UNIT-IV Evolution of Communities; Phylogenetic systematics; evolutionary Eco-morphology; compartmentation in communities (trophic levels, guild structure, and food webs); Connectance: pyramids of numbers, biomass, and energy; energy flow and ecological energetics; secondary succession and transition matrices; community matrix; saturation with individuals and with species; species diversity; community stability; evolutionary convergence and ecological equivalents; evolution of communities; pseudo-communities**.** **(10 Hours)**

UNIT-V Optimality approaches and evolutionary models to understand strategies for foraging, predator-prey interactions, competition, group living, sexual selection and mate choice, parental care. **(10 Hours)**

UNIT-VI Dispersal and evolutionary history in determining the spatial distribution of organisms; Biogeography - Distribution of communities and island biogeography; Biogeography and design of natural reserves; Landscape ecology. **(10 Hours)**

Text Books:

1. Pianka, E.R. Evolutionary Ecology. Eric R. Pianka, e-book, 2011.
2. J.H. Brown and M.V. Lomolino, Biogeography (Second Edition), Sinauer Associates, 1998.
3. Mayhew, PJ 2006, Discovering Evolutionary Ecology, Oxford University Press.

Reference Books:

1. Douglas J. Futuyma, 1998. Evolutionary Biology, Sinauer Associates, Inc. Sunderland
2. Fox, CW, Roff, DA Fairbairn 2001 Evolutionary Ecology: Concepts and Case studies, Oxford University press.

COURSE OUTCOME: Students will be equipped with better understanding of evolutionary biology and its importance and be able to describe and interpret different metrics central to both ecology and evolution

AQUATIC ECOLOGY

ECOL 413 **CREDITS: 4**

COURSE OBJECTIVES: To understand the ecology and functioning of different aquatic ecosystems, components and interactions.

UNIT-I Introduction to fundamentals of aquatic ecology; Components of aquatic ecosystems - Abiotic factors (light - temperature - salinity – pressure) – Biotic factors; Different types of aquatic ecosystems: Freshwater, Wetlands, Estuarine and marine ecosystems; Ecological adaptations of aquatic flora and fauna: freshwater, estuarine, pelagic, inter tidal, tide pools and deep sea. **(10 Hours)**

UNIT-II Freshwater ecosystem: lentic water bodies, Pond, lakes and their classification, Indian lakes and their ecology, Indian reservoirs and their ecology; lotic water bodies: streams, springs, major Indian rivers; River-continuum concept; Hydrophytes **(10 Hours)**

UNIT-III Coastal and Marine ecosystems– fauna and floral diversity – Phytoplankton and their classification, Primary productivity. Intertidal ecology – zonation and habitats - subtidal ecology. Major habitats; sea grasses, seaweeds, mangroves, coral reef, lagoons, sand dunes. Deep sea ecology with a focus on hydrothermal vents, cold seeps. Chemosynthesis Vs Photosynthesis. Manganese nodule associated communities, seamount ecology **(10 Hours)**

UNIT IV Aquatic faunal diversity and their associations in aquatic environment; inquilinism - phoresis - epizoism - mutualism - communalism – symbiosis (Vibrio-Squid symbiosis) – parasitism-Epibiosis. Fouling, Boring communities and their ecology. Native vs Invasive species. Invasive species in Indian waters and their ecology and impacts, Algal blooms and their ecology in Indian waters, Endemism. Vulnerability in aquatic organisms and marine conservation programmes **(10 Hours)**

UNIT-V Introduction to aquatic chemical ecology. Chemical signals structure marine populations, communities, and ecosystems. Chemical defense patterns. Chemical ecology of aquatic microbes: within the bacterial world (chemical ecology of *Vibrio cholerae*), within protists and cross-kingdom signaling, pelagic interactions**:** diatom-copepod interactions. Applied chemical ecology: Medicinal value of aquatic organisms, Natural product antifoulants and coatings development. **(10 Hours)**

UNIT-VI Biological sampling of surface and subsurface sediment and water (Grab, Niskin water samplers and CTD Rosette). Flow cytometry for quantification of picoplankton. Methodology for biological sampling (flora and fauna) in rocky, sandy and muddy shore: Microphytobenthos, macrofauna and meiofauna. Estimation of Chlorophyll-a. Biofoulers and borers: Collection and Identifications. Morphometric measurements of fish: Length-weight relationship of fish. Calculation of Shannon-wiener Diversity Index from an ecological dataset. Ecological investigation of Tide pools. **(10 Hours)**

Text Books:

1. Olandao Martin. (2017). Aquatic Ecology and Biodiversity. Publisher: Callisto ISBN: 9781632398215, 1632398214.
2. Vincent Jennings, (2016). Aquatic Ecology. Publishing House Syrawood, ISBN: 9781682866153, 1682866157

Reference Books:

1. Walter Dodds and Matt Whiles. (2010). Freshwater Ecology -Concepts and Environmental Applications of Limnology 2nd Edition eBook ISBN: 9780080884776: Academic Press.
2. Nybakkan J.N. (1997). Marine Biology-An ecological approach. Additon Wesley, Educational publication Inc.
3. Puglisi, M. P., & Becerro, M. A. (Eds.). (2018). Chemical ecology: the ecological impacts of marine natural products. CRC Press.
4. McClintock, J. B., & Baker, B. J. (2001). Marine chemical ecology. CRC press.

COURSE OUTCOME: Students will be able to understand the different types of aquatic environment, importance of interaction of living and non-living things, adaptations and will get an insight about chemical ecology and its industrial applications.

REMOTE SENSING AND GIS

ECOL: 501 **CREDITS: 4**

COURSE OBJECTIVES: To make students understand the fundamental principles, sensors characteristics and applications of different types of remote sensing. To introduce students the importance of spatial mapping and modeling in GIS for natural resources management**.** To provide students the various satellite data sets that are freely available in different repository, the procedure to download and processing. It is also aimed to give hands-on practical on geometric correction, preprocessing, classification, accuracy assessment and map composition

UNIT-I Principles of Remote Sensing: Concepts of Remote Sensing, Electromagnetic spectrum – visible, infrared and thermal, microwave regions, effects of atmosphere – absorption, scattering, reflection; Principle of scanner and CCD array, Spectral reflectance of earth's surface features in different wavelength region of electromagnetic spectrum: spectral characteristics of surface features (soil, vegetation, water). (a) Thermal remote sensing: Basic principles, Radiation laws, Sensing radiant energy, Thermal sensors, characteristics of image and their uses. (b) Microwave remote sensing: Basic definitions and principles, advantages, Types of microwave systems - RADAR, SLAR, SAR. **(10 Hours)**

UNIT-II Satellite and Sensors - Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT, IKONOS; Orbital characteristics, Data products. General characteristics, spectral resolution spatial resolution, temporal resolution and radiometric resolution; Digital Image Processing- Principles, Image rectification and restoration, Image enhancement and Mosaicing. Image classification - Supervised, Unsupervised, Ground truth data, Classification accuracy assessment – commission error, omission error and Kappa statistics. **(10 Hours)**

UNIT-III Air borne and space borne data: Fundamentals of photogrammetry, aerial cameras, planning of aerial photography, principles of stereo-photography, parallax; characteristics of aerial photographs; Elements of image interpretation - visual interpretation of aerial photographs and satellite imageries, instruments used in interpretation. Satellite data availability – United States Geological Survey (USGS), Bhuvan, India, European Space Agency (ESA), National Oceanic and Atmospheric Administration (NOAA), National Aeronautics and Space Administration (NASA). **(10 Hours)**

UNIT-IV Geographic Information System (GIS): Basic principles, components and terminologies, Raster and vector data structure, attribute data, Map projection, Digital cartography, elements of map, thematic map, proximity analysis, overlay analysis, GIS software – commercial and open source, Global Positioning System (GPS) - Basic principles, satellite constellation, control segment and user segment, AGPS and DGPS and applications. **(10 Hours)**

UNIT-V Applications of Remote Sensing and GIS: Forest resources - forest type mapping, forest density mapping, change analysis, matrix analysis; water resources - mapping surface waterbody, flood and inundation mapping; agriculture – crop area and yield estimation, damage detection, plant disease detection; disaster mapping – forest fire, fire frequency mapping, fire trend analysis, landslide, land use and land cover mapping, land cover dynamics. **(10 Hours)**

UNIT-VI Satellite data downloading from Earth Explorer, Layer stacking, False color composite preparation, Unsupervised classification, Supervised classification, Head-up interpretation, Accuracy assessment, Map composition **(10 Hours)**

Text books

1. Li J., (2021) Satellite Remote Sensing Technologies, Springer Publications.
2. Rees W.G (2013) Physical Principles of Remote sensing (3 rd edition), Scott polar, Research Institute, University of Cambridge, New York.
3. George Joseph (2008) Fundamentals of Remote Sensing (2 nd edition), Universities press, Hyderabad.
4. Lillies T. M. and Kiefer R.W (2003) Remote Sensing and Image Interpretation, John Wiley and Sons.
5. Emery W. and Camps A., (2017) Introduction to Satellite Remote Sensing 1st Edition Atmosphere, Ocean, Land and Cryosphere Applications, Elsevier Publications

Reference books

1. Raizer, V (2017) Advances in Passive Microwave Remote Sensing of Oceans 1st Edition CRC Press
2. Solimini, D., (2016) Understanding Earth Observation: The Electromagnetic Foundation of Remote Sensing (Remote Sensing and Digital Image Processing) 1st Edition, Springer;
3. Estes J. E., and Senger, L.W. (1973), Remote Sensing Techniques for Environmental Analysis, John Wiley and Sons New York.
4. Fischer, and Nijkamp, P (1993). Geographic Information Systems – Spatial Modeling and Policy Evaluation, Springer – Verlag.

COURSE OUTCOME: At the end of the course, students will know about the different types of remote sensing data available and its application in mapping and monitoring the natural resources, Students will also know the potential applications of GIS mapping and modeling in natural resources management. Students will know the different repository from where the relevant satellite data could be downloaded. Students will also have a hands-on experience in satellite data handling, processing, classification and map compo

BEHAVIORAL ECOLOGY

ECOL: 502 **CREDITS: 4**

COURSE OBJECTIVES: To make students know the behavioral ecological concepts and theories to understand the dynamic nature of species interactions and natural selection.

UNIT–I Introduction to Behavioural Ecology; evolution and natural selection; fitness and adaptation; proximate and ultimate causes of behavior; fixed action patterns; imprinting, associate and non-associate learning; Conservation and behaviour. **(10 Hours)**

UNI–II Evolutionarily Stable Strategies (ESS), Game theory and contests: hawk-dove, prisoners's dilemma, sexual and natural selection, evolution of social behaviour, inclusive fitness, evolution of altruism: kin selection and reciprocal altruism. Social insect colonies as superorganisms, haplodiploidy, division of labour and castes. Case studies. **(10 Hours)**

UNIT–III Foraging ecology, search and handling time, optimization, generalization and specialization, prey and predator relationship, territoriality, group foraging, selfish herd concept, interspecific mutualisms. **(10 Hours)**

UNIT–IV Overview on reproductive behaviour and social organisation, Red Queen hypothesis and the evolution of sexual behaviour, different types of breeding systems in animals. Mate choice and mating systems in animals. Cooperative breeding in birds and mammals. Brood parasitism in cuckoos and other birds. **(10 Hours)**

UNIT–V Roles of studying the animal behaviour in conservation and wildlife management. Overview of research methods in sampling of behaviour; time budgets and ethogram; designing behavioural studies, seminars. **(10 Hours)**

UNIT–VI Practical demonstrations on various study methods, tools and techniques to observe the behaviour of different animal taxa including certain animals that occur inside the campus of Pondicherry University. **(10 Hours)**

Text Books:

1. Michael D. Breed, Janice Moore (2016) Animal Behavior (Second Edition). Elsevier, 546 p.
2. David McFarland, 1998. Animal Behaviour: Psychobiology, ethology and evolution. Longman (3rd Edition), 592 p.
3. . J.R. Krebs. 1993. An introduction to behavioural ecology. Blackwell Publishing.

Reference Books:

1. J. R Krebs and N.B. Davies 1984. Behavioural Ecology: an evolutionary approach. Sinauer Associates.
2. E.S. Morton and B. Stutchbury.2001. Behavioural ecology.. Academic Press.
3. David McFarland 1981. The Oxford Companion to Animal Behvaiour, Oxford University Press, 670 p.

COURSE OUTCOME: Students will have better understanding about the behavioral ecology and its significance.

ENVIRONMENTAL IMPACT ASSESSMENT

EVNS: 503 **CREDITS: 4**

COURSE OBJECTIVES: To provide theoretical and as well as practical knowledge, to plan and carry out an environmental impact assessment and to develop environmental management plans in compliance with the environmental clearance procedures in India.

UNIT – I Development Projects and Impacts; EIA and types of EIA methods; definition of EIA & EIS. Negative & positive aspects & uncertainties in EIA, Historical synopsis; Approach to EIA studies – mandatory requirements, project screening, scoping. Environmental baselines, best practices, terms of reference. Phases of EIA – Identification, Prediction, Evaluation, Decision Making and Post impact Monitoring the question of Significance; Complexities in environmental measurement; Special issues & concerns for different type of projects with case studies. **(10 Hours)**

UNIT – II Review of methodologies of EIA: Impact Identification Techniques – Checklists, Matrices, Map Overlays, Networks, Leopold Matrix; Environmental Evaluation System; Economic Approaches to EIA (Cost Benefit with market and shadow prices); Ecological Mapping. **(10 Hours)**

UNIT – III National Policy on EIA and Regulatory Framework: Environmental Impact Assessment Notification 2006 and Coastal Zone Notification 1991; Environmental Clearance Process in India; Legislative requirements (discharge requirements and area restrictions); Environmental Appraisal procedure for mining, industrial, thermal power, nuclear power, and multipurpose river valley projects; Role of Central & State pollution control boards in Environmental Protection**.** **(10 Hours)**

UNIT – IV Environmental, Methods, Risk Analysis-: Definition of Environment Audit & its importance for industries, Requirements of Rule 14 for Environmental Audit under Environmental protection Act 1986, Definitions of a. Signatory, b. Consumption Audit, c. Pollution Audit, d. Hazardous Audit, e. Solid waste Audit, f. Disposal Audit, g. Cost Audit, h. Investment Audit, i. Voluntary Audit. Need & Definition of Risk Analysis, Identification of risk due to project activities, Cost of alleviation of risk & impact on project cost, Disaster Management. **(10 Hours)**

UNIT – V Environmental impact Analysis of any Development Project: Public Participation, Preparation of Environmental Management plans (EMPs): Environmental management overview, Environmental management Issues and considerations. Environmental management systems (EMS) – Principles, Elements and Standards of ISO 14001 & ISO18001. Introduction to CIA and SEA.

(10 Hours)

UNIT – VI Case Studies and report preparation: Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, Highway project, Gas pipeline construction project, Municipal Solid waste processing plant, Air ports. **(10 Hours)**

Text Books

1. Hanna, K., (Ed.), 2022. Routledge Handbook of Environmental Impact Assessment, Routledge, Taylor and Francis Group.
2. Glasson. J., 2019. Introduction to Environmental Impact Assessment, 5th Edition, Taylor and Francis.
3. Reddy, A and Mereddy, 2017. Environmental Impact Assessment, 1st Edition, Elsevier Publication.
4. Anji, R M., 2017. Environmental Impact Assessment. Butterworth-Heinemann.

5. Lawrence, D. P., 2003. Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley & Sons, Inc.
6. Canter L.W., 1996. Environmental Impact Assessment, Mc Graw Hill Publication, New York.

Reference Books

1. Salim M., Zobaidul, K., 2018. Evaluating Environmental and Social Impact Assessment in Developing Countries, Elsevier.
2. Ch. Wood, 1996. Environmental Impact Assessment – A comparative review.
3. Therivel, R., 1996. Methods of Environmental Impact Assessment, Peter Morris.
4. Welsh Office, 1989. Environmental Assessment – A guide to the procedure, DoE.

COURSE OUTCOME: Students will be equipped to identify environmentally sound technologies or policies to resolve environmental problems.

AGRICULTURE AND WEED ECOLOGY

ECOL: 461 **CREDITS: 4**

COURSE OBJECTIVES: To introduce students to the ecological effects of weeds in agriculture.

UNIT-I Agriculture – An interdependent resource, Introduction, Scope and branches of Agriculture, Evolution of agricultural systems and their environmental implications. Agricultural practices - Types**:** Shifting cultivation, multiple and rotational cropping systems, nutrient deficiency and management of seeds. Agricultural production- Application of organic manures, chemical fertilizers, and agricultural practices, their environmental impacts. Ploughing, agro-chemical fertilizers and biocides on soil health and ground water pollution. **(10 Hours)**

UNIT-II Definition, Origin, and Characteristics of Weeds: Seed Production dormancy, Vegetative Reproduction and Root system. Classification of Weeds: Based on life span (Ontogeny) – Annuals, Biennials and Perennials. Based on morphological characteristics, Based on Place of Occurrence. Role of Weeds in the Agricultural field - Weed Biology and Ecology, Persistence Nature of Weeds: Climatic factor, edaphically factors and biotic factors. Survival mechanism of weeds: Production of Seeds, Dissemination/dispersal/migration of weed seeds, Seed Germination, Vegetative propagation/Asexual Reproduction, Dormancy, Evasiveness, Weed population, Agricultural ecotypes and self-regeneration. Allelopathy: Effect of weed on Crops, Effect of weeds on Weeds, Effect of Crops on Weeds and Biodiversity of Weeds. **(10 Hours)**

UNIT-III Weed management methods: Mechanical weed control -- merits, Implements,Function, Disadvantages, Dry land weeder**.** Cultural method of weed: Field preparation, Crop rotation, growing of intercrops, Mulching, Solarization, Reduction in Area under bunds and Stale seedbed, Blind tillage, Crop management practices, Merits of cultural method. Biological weed control: Qualities of bio-agent, merits, demerits, Outstanding and feasible examples of biological weed control and biological control of weeds in crop field in India. **(10 Hours)**

UNIT-IV Soil management in agriculture, Land preparation, planting, irrigation, weeding and crop protection. Agricultural exports and imports - Trends and direction, environmentally sustainable agriculture for the third world counties - INM, IPM with biological control and Eco-agriculture. Crop-Weed Competition: Competition for Nutrients, Light, Water, and Co2, Critical Period of Crop – Weed Competition in Weed management. Factors of influencing period of Crop – Weed Competition and Factors affecting Competitive ability of crops against Weeds. **(10 Hours)**

UNIT-V Microbial Agriculture community, Bacterial role in Nutrient cycle, Importance of microbial control on Agriculture, Advantages of microbial control, Advantages and Disadvantages of microbes; beneficial microorganisms in agriculture and its sustainability. **(10 Hours)**

UNIT-VI Agricultural exports and imports - Trends and direction, environmentally sustainable agriculture for the third world counties - INM, IPM with biological control and Eco-agriculture. Chemical Weed control methods**:** Merits and demerits, Classification of herbicides, Time and application of herbicide application. Incorporation of herbicides in the soils, Rotation and Residue management. Integrated Weed management**:** Advantages of IWM, IWM for important crops, Rice nursery, Transplanted Rice, Rainfed Rice, Wheat, Sorghum &maize, Finger millet, Pulses, Oilseeds,

Cotton, Sugarcane and Vegetable crops. Control of perennial and problematic weeds **:** Bermuda grass ***(Cynodon dactylon***, Control measures, ***Cyperus*** Species: ***Cyperus esculentus*** (Yellow nutsedge), Habitat and habit, Control measures. *Solanum nigrum* – control measures. *Parthenium hysterophorus* **–** control measures. Parasitic weeds: *Loranthus* (Bird vine), *Cuscuta* sp.—control measures.

(10 Hours)

Text books:

1. Ahmed H. (2012) Weed Ecology and Control, LAP Lambert Academic Publishing
2. Richardson, David M, Pysek Petre 2008. Fifty years of invasion ecology – the Legacy of Charles Elton., Volume 14, pp. 161-168(8), Blackwell Publishing.
3. Azam-Ali, 2006. Principles of Agronomy. Publisher: Agrosciences book centre, Ansari Road, New Delhi.
4. Muzafar Ahmad Bhat, Suraksha Chanotra, Shahina A. Nagoo, Zafar Iqbal Buhroo. 2023. Genetics of Bio-Chemical Techniques. ISBN : 978-93-91208-74-5 Pages : 172. Ip Innovative Publication Pvt Ltd.

References books:

1. Singh and Ajay Kumar, 2006. Sedges and Grasses of Eastern Uttar Pradesh in 2 Vol. Publisher: Daya Publishing House, Ansari Road, New Delhi.
2. Gupta**.** O. P.2007.Fundamentals of Weed Science: A Text Book, Jodhpur, Agrobios, xviii, 380 p., tables, figs., ISBN 81-7754-307-5.
3. Subramaniam, S. 2006. All about Weed Control. Publisher: Agroscience book Centre, Ansari Road, New Delhi.
4. Farzana Ashrafi Neela, and Rohit Shankar Mane. 2022. Environmental Microbiology. ISBN : 978-93-91208-22-6. Pages: 142. Ip Innovative Publication Pvt Ltd.

COURSE OUTCOME: Students will understand the different types of weeds in agriculture areas, ecology of weeds and control measures.

LANDSCAPE ECOLOGY AND PLANNING

ECOL: 462 **CREDITS: 4**

COURSE OBJECTIVES: To focus on spatial relationships and the interactions between patterns and processes in landscape ecology

UNIT – I Land and Landscape processes; Hierarchy: ecosystems to land units; Ecological principles at work with Landscapes; From Ecosystem ecology to Landscape Ecology. **(10 Hours)**

UNIT-II Spatial Heterogeneity and Landscape; History of Landscape Ecology; Concept of Scale and technological advances; Patch – Corridor – Matrix model – Disturbance, remnant, environmental, and introduced patches **(10 Hours)**

UNIT–III Patches as Islands–Patch Size and Edge effect; Habitat Fragmentation and Nonnative Species; Metapopulation Dynamics and Appropriate Management; Understanding Landscape Structure Using Landscape Metrics. **(10 Hours)**

UNIT – IV Land Use/Cover Change; Ecosystem and biodiversity impacts; Inventory and Tools for wasteland assessment and evaluation; Land Reclamation and Restoration; Natural hazard mitigation/erosion; Concept of ecological land degradation – desertification, deforestation, water logging, salinization and soil erosion**.** **(10 Hours)**

UNIT- V Landscape ecology Practices in Planning: Landscape Connectivity and Urban Networks – Parks, greenbelts and greenways/green infrastructure; Designing Landscapes and Urban Sustainability. Field Report Participatory Sketch Mapping of Landscape Features (**10 Hours)**

UNIT – VI Laboratory work/Hands-on training on: Creating landscape pattern; Using neutral landscape models; Understanding landscape metrics; Scale detection using spatial stats; Spatial dynamics of ecosystem processes; Assessing multi-scale landscape connectivity. **(10 Hours)**

Text Books

1. Turner MG Gardner, RH, 2015. Landscape Ecology in Theory and Practice, 2nd Edition, Springer Nature.
2. Lopez,RD,Frohn,RC,2017.RemoteSensingforLandscapeEcology:NewMetricIndicators CRC Press; 2edition
3. Forman RTT, and M Godron.1986. Landscape ecology. Wiley, New York.

Reference Books

1. Risser PG, JR Karr, and RTT Forman.1984. Landscape ecology: directions andapproaches. Special Publ. No. 2, I11. Natural Hist. Surv.,Champaign.
2. Turner MG.1989. Landscape ecology: the effect of pattern on process. Ann. Rev. Ecol. Syst. 20:171-197.
3. Turner MG.2005. Landscape ecology: what is the state of the science? Annu. Rev. Ecol.Evol. Syst.36:319-44.
4. Forman RTT.1995. Land mosaics: the ecology of landscapes and regions.Cambridge University Press, Cambridge,England.

COURSE OUTCOME: Students will explain the implications of landscape pattern on populations, communities and ecosystems

FOREST BOTANY

ECOL: 463 **CREDITS: 4**

COURSE OBJECTIVES: To understand the high diversity of tropical forests and develop skills to recognize major plant families, besides learning the principles of plant systematics and about ecologically and economically valuable plant resources and their conservation.

UNIT-I Botanical diversity of tropical forests and causes of high diversity; Predominant tropical plant families and their species diversity; Technical terms of Angiosperms; Plant functional traits and their importance in climate change scenario; Study of selected major tropical plant families, with details on (i) distribution (ii) diagnostic features/Field recognition features (iii) description (iv) ecological and economic importance of at least 5 species in each family:
Families:Dipterocarpaceae
Myrtaceae
Caesalpiniaceae **(10 Hours)**

UNIT-II Outlines of Principles of Plant Systematics and type concept; Forest botany as a field endeavour: Key field characters and family/species recognition using field keys. Floras and their usage: Emphasis on Asian Floras; e-Floras.
Families: Rubiaceae
Verbenaceae
Myristicaceae **(10 Hours)**

UNIT-III Plant preservation techniques; Herbaria - scope and need; world and regional herbaria; Botanic gardens and their role in species conservation; Botanic Gardens Conservation International-World's largest Plant Conservation Network and BGCI database and its e-resources on Plant Search, Garden, Global tree and Threat Search databases; Botanical Survey of India: Organisation and role.
Families: Lauraceae
Euphorbiaceae **(10 Hours)**

UNIT-IV Families: Moraceae
Arecaceae
Forest resources: Timber resources: Selected tropical timbers: Teak, *Dalbergia*, *Petrocarpus* and Neem. **(10 Hours)**

UNIT-V Medicinal Plant resources: Selected ten medicinal plants: Name, part used, active constituents, uses and distribution and conservation significance;*Adhatoda*, Licorice, *Cinchona*, Periwinkle (*Catharanthusroseus*) *Phyllanthusamarus*, *Acalypha indica, Terminalia chebula, Taxus baccata*, Lotus &*Strychnos nux-vomica.* **(10 Hours)**

UNIT-VI Critical study of species belonging to about listed ten plant families; Skill development in recognizing plant families based on key features and identification of species using vegetative key and Floras; Comparative analysis of closely related plant families and species belonging to same genus based on field recognition features and Floras; Analyses of genus:species ratio for selected genera of the above families – *Syzygium*, *Ixora*, *Clerodendrum*, *Cinnamomum*, *Phyllanthus* and *Ficus* **(10 Hours)**

Text Books:

1. Keller, R.2023.A Field Guide to Tropical Plant Families. Spinger, Laussane, Switzerland. 494p.
2. Mabberley, D. J.2017. Mabberley's Plant book. Cambridge Univ. Press. 4th Ed. 1102p.

Reference:

1. Jones & Leschinger. 1987. Plant Systematics. John Wiley.

COURSE OUTCOME: Students will acquire the skills to identify major plant families, resource values of key plant groups and their conservation significance.

SCIENCE COMMUNICATION

ECOL: 464 ` **CREDITS: 4**

COURSE OBJECTIVES: Students will be introduced to popular science communication in the broader contexts in communication science, cultural, practical and policy-related role of science communication in a wider society to variety of audience.

UNIT-I Why Science Communication – Philosophy and history of Science Communication of Science in through human history; Informal and formal communication. **(10 Hours)**

UNIT-II Communication Media – Tools of communication – voice media – visual media– traditional media – mass communication. **(10 Hours)**

UNIT-III Writing to communicate – writing laboratory - How to be effective communicator of science – Specialized tools associated with science. (**10 Hours)**

UNIT-IV Communication through scientific report- writing about research paper, collection of review of literature, proposal writing, editorial, review writing. Scientific data collection tools: Google scholar, Research gate, Scopus etc., **(10 Hours)**

UNIT-V Electronic media for communication – practice laboratory for effective presentation to lay audience as well as peers. **(10 Hours)**

UNIT-VI Communicating complex ideas to lay and young audience – communicating controversial ideas; communication for policymaking and conflict resolution. **(10 Hours)**

Text Books

1. Laura Bowater, Kay Yeoman 2012. Science Communication: A Practical Guide for Scientists ISBN: 978-1-119-99313-1 December 2012 Wiley-Blackwell 384Pages
2. Mark Brake and Emma Weitkamp 2009. Introducing Science Communication: A Practical Guide. Publisher: Palgrave; 188 pages. ISBN-10: 023057386X
3. Bucchi, M. & Trench, B. (Eds.) (2008). Handbook of Public Communication on Science and Technology. London:Routledge.

Reference Book

1. Cheng, D., Claessens, M., Gascoigne, T., Metcalfe, J., Schiele, B., & Shi, S. (eds.) (2008). Communicating Science in Social Contexts: New models, New Practices. New York:Springer.MIT Open source:
2. http://ocw.mit.edu/courses/science-technology-and-society/sts-034-science communication-a-practical-guide-fall-2011
3. James G, Paradis and Muriel L. Zimmerman, the MIT Guide to Science and Engineering Communication. MIT Press, UK, 2002.

COURSE OUTCOME: Students will know and understand the complexity of communication media and to use them efficiently.

PLANT-ANIMAL INTERACTIONS

ECOL: 465 **CREDITS: 4**

COURSE OBJECTIVES: To understand the richness of interactions between plants and animals.

UNIT-I Ecology and evolution of antagonistic and mutualistic relationships between plants and animals. Distribution of Plant-Animal Interactions. Role of plants and animals in global ecosystem services, pharmaceutical industry. Case studies. Evolution of interaction. **(10 Hours)**

UNIT-II Pollination Ecology - Evolution of pollination systems. Floral morphology and adaptations for pollination: pollination syndromes. Pollinator diversity. Global patterns of diversity and distribution of pollinators. Pollination: benefits and threats. Floral rewards. Foraging ecology of pollinators. Figs and fig wasps, orchids and euglosine bees, mistletoes and birds. **(10 Hours)**

UNIT-III Frugivory and Seed Dispersal - Evolution of fruit type and frugivory. Fruity syndromes and fruit types. Keystone fruit resources and dispersal. Seed shadow seed predators Seed dispersal and forest structure/mega faunal dispersal. **(10 Hours)**

UNIT-IV Herbivory - Plant-herbivore interactions, quantitative and qualitative defenses, animal offence chemistry of plants defenses, grazing systems, ant-plant mutualisms, ecological effects of herbivores on plant population communities**.** **(10 Hours)**

UNIT-V Conservation Mutualisms- Global declines in pollinators and frugivores due to habitat loss, fragmentation, pesticide use, hunting and climate change. Effects on plant populations. Mutualism as a Source of Evolutionary Innovation. Global conservation efforts**.** **(10 Hours)**

UNIT-VI Field studies and report preparation – Assessment and categorization of Pollinator in connection with availability of plant resources (e.g. Birds and plants), Herbivore plants and their evolutionary significance in dry deciduous forest of Pondicherry University (e.g. Palatable thorny plants). Map the occurrence of any one mutualistic animal/plant or both in the University campus. Inventorization of key stone species of the tropical dry evergreen forest. **(10 Hours)**

Text books

1. Del-Claro, K., Torezan-Silingardi, H.M., 2021. Plant-animal interactions, Source of biodiversity, Springer Nature Switzerland.
2. Herrera, C.M. and Pellmyr, O. 2003. Plant animal interactions: an evolutionary approach. Blackwell publishing, UK.
3. Schaeffer, H.M., and Ruxton, G.D. (Eds), 2011. Plant-Animal Communication. Oxford University Press.

Reference Books:

1. Clements, I., 2018. Plant-Animal Interactions: An Ecological Approach. Syrawood
2. Kumar, H.D., 2000. Plant animal interactions. Affiliated East West press private Limited, New Delhi.
3. Abrahamson, W. G., 1988. Plant-Animal Interactions. McGraw-Hill.
4. Howe, H.F. and Westley, L. 1988. Ecological relationships and Animals. Oxford University Press, Oxford.

COURSE OUTCOME: Students will know the ecological and evolutionary interrelationships between animals and plants.

ORNITHOLOGY

ECOL: 466 **CREDITS: 4**

COURSE OBJECTIVES: To understand the biology, habitat and behavior of birds, and their conservation perspectives.

UNIT-I Introduction to birds and their habitats. History of Indian Ornithology. Avian phylogeny. Bird anatomy and physiology. Adaptation and evolution of flight and feathers. Identifying birds in the field. **(10 Hours)**

UNIT-II Evolutionary and history of birds in the light of recent fossil evidence. Avian biogeography, diversity and distribution. Adaptive radiation of birds: **(10 Hours)**

UNIT-III Ecology and evolution of migration: long distance and local migration. Cues used for migration. Recent evidence and case studies, Modern tools to study migration biology**. (10 Hours)**

UNIT-IV Bird Song, Anatomy, function, learning, inter and intraspecific communication, signals and deception. Population ecology of birds. Techniques to study bird's abundances, habitat and ecology. **(10 Hours)**

UNIT-V Economic ornithology. Threatened birds. Global efforts for bird conservation, red-listing of birds, important bird areas, Conservation perspectives of birds. **(10 Hours)**

UNIT-VI Field ornithology - Assessment and monitoring of populations and habitats of birds. Citizen Science in Birds Conservation. **(10 Hours)**

Text Books;

1. J. Fitzpatrick, J. W. 2016. Handbook of Bird Biology (Cornell Lab of Ornithology). Wiley-Blackwell (3rd edition).
2. PETTINGILL, OS JR. (1961). A laboratory and field manual of ornithology. Burgers publishing Co. Minnea Polis (latest edition).

Reference Books:

1. ALI, S and RIPLEY, D 1989. Hand book of the birds of India and Pakistan (Compact edition), Oxford University Press.
2. Ali, S. 2003. The book of Indian Birds. Oxford University Press.
3. Asad R. Rahmani, 2012. Threatened Birds of India: Their conservation requirements, Oxford University Press, 870 p.

COURSE OUTCOME: Students will have better understanding of avian diversity, ecological and evolutionary processes as illuminated by a long tradition of avian research in India, and a practical toolkit for studying birds in the field.

BIOLOGICAL INVASIONS

ECOL: 467 **CREDITS: 4**

COURSE OBJECTIVES: To emphasize the ecological and economic impacts of invasive species and to use case studies from invasion biology to illustrate and explain their potential, process and management options.

UNIT-I Biological invasions: Introduction- Elton's hypothesis – Invasion patterns and Process- Biological attributes for invasion: Reproductive potential Allelopathy – Phenotypic plasticity- fitness to the new environment. **(10 Hours)**

UNIT-II Hypotheses for invasion success: Natural enemy hypothesis- Evolution of invasiveness hypothesis-Empty niche hypothesis-Novel weapon hypothesis- Disturbance hypothesis and Propagule pressure hypothesis - worst 100 invasive species- Databases for biological invasions. **(10 Hours)**

UNIT-III Marine bio invasions: Introduction- Natural and climate change mediated invasions-vectors of marine invasions- Biofouling- Ballest water management – establishment of marine invasive species - Ecological factors affecting community invisibility **(10 Hours)**

UNIT-IV Impacts and Management of Invasions: Impacts of exotics on Biodiversity- Productivity- Nutrient cycling. Management: Biocontrol programmes- Mechanical and chemical control- Positive utilization- Quarantine and EIA assessments. **(10 Hours)**

UNIT-V Current developments in invasion studies: Global climate change and bioinvasions – Economic damage caused by invasive species- Economic development and biological invasions - Mathematical models for biological invasion – Role of remote sensing in invasion studies. **(10 Hours)**

UNIT-VI Study the origin, introduced region, invasive potentials and impacts of invasiveness of the following species: *Lantana camara* , *Chromolaena odorata*, *Prosopis juliflora*, *Mikania micrantha*, *Eichhornia crassipes*, *Caulerpa taxifolia and Kappaphycus alvarezii,* Rabbits, Indian mina, brown tree snake*, Zebra mussels* and lion fish. **(10 Hours)**

Text books

1. Jonathan M. Jeschke, Tina Heger (2018). Invasion Biology: Hypotheses and Evidence. CABI. ISBN: 9781780647647, 1780647646
2. Canning-Clode, João (2016). Biological Invasions in Changing Ecosystems (Vectors, Ecological Impacts, Management and Predictions); OPEN ASSESS, ISBN 978-3-11-043866-6
3. Rebecca Waterman, (2015). Biological Invasions: Patterns, Management & Economic Impacts (Environmental Research Advances) Nova Science Publishers Inc; UK ed. Edition ISBN-10: 1634820193
4. David Pimentel, (2011). Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal, and Microbe Species, Second Edition, Taylor & Francis. ISBN 978143982990
5. Cang Hui, David M. Richardson 2017. Invasion Dynamics. Oxford University Press. ISBN: 9780191062520, 0191062529

6. Quentin C.B. Cronk, Janice L. Fuller · 2017. Plant Invaders: The Threat to Natural Ecosystems. Taylor & Francis. ISBN: 1138158739, 9781138158733.
7. Rilov, G. and Crooks. (2009). Biological invasions in marine ecosystems- ecological, Managemant and Geographic Perspectives. Springer-Verlag, Berlin Heideberg.
8. Prabhat Kumar Rai. 2013. Plant Invasion Ecology Impacts and Sustainable Management. Nova Publishers. ISBN: 9781629481111, 1629481114.
9. Gowher A. Wani, Manzoor A. Shah · 2020. The Eco-physiological and Genetic Basis of Invasiveness. Cambridge Scholars Publishing.ISBN: 9781527554900, 1527554902
10. Ramakrishnan, P.S. (1991). *Ecology of Biological Invasion in the Tropics.* International Scientific Publications, New Delhi,

Reference books

1. Charles S. Elton, Daniel Simberloff, Anthony Ricciardi · 2020. The Ecology of Invasions by Animals and Plants. Springer International Publishing.ISBN: 9783030347215, 3030347214
2. Ana Sofia Vaz, Ross Taylor Shackleton,Joana Raquel Vicente, Joao Pradinho Honrado, Ana Novoa 2021. Invaders on the Horizon! Scanning the Future of Invasion Science and Management. Frontiers Media SA. ISBN: 9782889716401, 2889716406
3. Michael R. Ielmini, Thammineni Pullaiah 2021. Invasive Alien Species: Observations and Issues from Around the World. Wiley. ISBN: 9781119607014, 1119607019
4. Periklis Kleitou, Jason Michael Hall-Spencer,Ioannis Giovos, Francesco Tiralongo. 2022.Biological Invasions in the Mediterranean Sea. Frontiers Media SA. ISBN: 9782832502624, 2832502628
5. Radu Cornel Guiaşu · 2016. Non-native Species and Their Role in the Environment: The Need for a Broader Perspective.Brill. ISBN:9789047426134, 9047426134

COURSE OUTCOME: Acquired the knowledge on the ecological process of invasion: characteristics of successful invaders and vulnerable ecosystems, and regulation, prevention and management. Have an understanding of the historical and current causes of biological invasions. Be familiar with the ways in which invasive plants and animals damage ecosystems, societies and economies

FOREST ECOLOGY

ECOL: 468 **CREDITS: 4**

COURSE OBJECTIVES: To introduce the structural and functional aspects of different forest ecosystems. To understand the role of physical environmental factors in forest dynamics. To explain the role of animals in forest functioning.

UNIT I: Forest Ecology: Introduction, human evolutionary dependence on forests, history of human impacts on forests, development of forestry, future evolution of forestry. Forest ecosystem, levels of biological interactions, ecosystem change. Structure of tropical forest, distribution and characteristics. Growth forms in plant life and seasonal rhythm (**10 Hours**).

UNIT II: Physical Environment and forest dynamics: Solar radiation – Physical nature of solar radiation, ecological effects of spectral quality, variations in the intensity, temporal variations. Temperature – geographical and temporal variations, effects of temperature on plants, animal adaptations to temperature, temperature and distribution of organisms. Soil – Physical properties of soil, soil water, chemical properties of soil, soil organic matter, soil biology, soil fertility and development, ecological significance of soil. Water – water cycle, adaptations of plants and animals to excess and deficit of water. Fire – types and occurrence of fires, effects of fire on soil, plants and animals, fire adaptations, ecosystem process. (**10 Hours**).

UNIT III: Regeneration Ecology: Introduction, sexual reproduction, regeneration strategies, flowering, reproductive cycles, pollination, role of animals in pollination, seed dispersal – role of animals in seed dispersal, seed bank, dormancy and germination. Production ecology – Primary producer– input, losses, net productivity and biomass, distribution of biomass. Consumer – herbivores, carnivores, decomposers. Carbon storage in forest – carbon allocation – role of coarse woody debris in forest ecosystems. (**10 Hours**).

UNIT IV: Nutrient cycling: nutrient addition, mineral weathering, atmospheric deposition, nutrient transport, assimilation, mycorrhizae, plant litter and return of nutrients to forest floor and soil, nutrient loss from forest ecosystem. Forest succession: Introduction, autogenic and allogenic succession, causes of succession, stages of succession, primary and secondary succession, facilitation, tolerance and inhibition. Gap dynamics. (**10 Hours**).

UNIT V: Animals: Plant defense, plant dilemma, insects – injury and plant defense. Role of animals in forest functioning – birds and arthropods. Wildlife habitat and fire – adaptations to fire-dependent ecosystem, kinds and abundance of animals, factors affecting animal response to fire. Influence of large animals on forest ecosystems- livestock grazing. Human impacts on forests, silviculture, human introduced exotic species. Rainforest destruction; Trends and causes for concern. (**10 Hours**).

UNIT VI: Disturbance: Disturbance as an ecosystem process, sources of disturbance, major disturbances in forest ecosystem, role of fire in forest ecosystems, fire exclusion, disturbance by wind, disturbance by floodwater, disturbance by insects and disease, logging, and land clearing, climate change. (**10 Hours**).

Text Books:

1. Kelvin S.H. Richard PT. Yves, C, 2015. Routledge Handbook of Forest Ecology. Routledge Publication, 652 pages, ISBN: 978-0-415-73545-2

2. Pertti Hari, P., Heliövaara, K, Liisa Kulmala L. 2012. Physical and Physiological Forest Ecology, Springer Publication
3. Barnes, B.V., Zak, D.R., Denton, S.R. and Spurr, S.H, 2010. Forest Ecology, 4th Edition, John Wiley & Sons, Inc, NY, USA.

Reference Book:

1. Perry, D.A. Oren R. and Hart. S.C. 2008. Forest Ecosystems (2nd Edition). John Hopkins University Press.
2. Kricher J. 2011 Tropical Ecology, Princeton University Press. ISBN-13: 978-0691115139
3. Richards, P.W.1996. Tropical rainforest. 2nd Edition Cambridge Univ. Press.
4. Sutton, S.L., T.C. Whitmore and A.C. Chadwick (eds) 1983. Tropical rainforests Ecology Management. Blackwell Sci. Publ. Oxford.
5. Kimmins, J.P., 1997, Forest Ecology: A foundation for sustainable management, 2nd Edition, Prentice Hall, Upper Saddle River, New Jersey.

COURSE OUTCOME: The students will know the structural and functional aspects of different forest ecosystems and their response to physical environmental factors. Students will understand the interactions of animals in forest functioning.

AGRO ECOSYSTEMS AND AGROFORESTRY

ECOL: 469 **CREDITS: 4**

COURSE OBJECTIVES: To impart students the management of agroecosystem through ecological approaches

UNIT-I: Definition, scope and characteristics: structure, sustainability, increased productivity and socioeconomic / cultural adaptability fundamental ecological features of agro forestry. Importance of agro forestry; ecological - waste landscapes, rehabilitation. **(10 Hours)**

UNIT-II: Scope, characteristics and types of agro ecosystems, an overview of agro ecology and agro ecosystems, ecological perspective of farming and economic crisis-farmers classification: important role of trees, soil. Characteristics and fertility, microclimate, hydrology associated biological components and productivity. **(10 Hours)**

UNIT-III: Systems of agro-forestry: designing and planning, plant arrangements, examples of agro forestry, forests in India: destruction and protection, role of (ICRAF) international Centre on agro forestry. Economics of agro-forestry-income source, livelihood and community development; resources-trade and other benefits. **(10 Hours)**

UNIT-IV: Management of agro ecosystems: ecological approaches to weed and pest management. Economics of agro forestry-income source, livelihood and community development; resources-trade and other benefits. - Resource, interactions among biotic communities - resource, competition, predation, and mutualism. **(10 Hours)**

UNIT-V: Stability, modernization, mechanization and various resources of agro ecosystems and agroforestry. **(10 Hours)**

UNIT –VI: Organic farming, Natural farming and Zero-budget farming, Perm agriculture and integrated technology, Zero-budget farming, Drip-Irrigation techniques and High yield Production. **(10 Hours)**

Text books:

1. Eliot Coleman 2018. The New Organic Grower, 3rd Edition: A Master's Manual of Tools and Techniques for the Home and Market Gardener**.** ISBN-13: 978-1603588171
2. S.B. Lal, Antony Joseph Raj. 2017. Agroforestry: theory and practices. Scientific Publishers. ISBN:9788172338671, 8172338678
3. Sharma, V. K. 2004. Trees and protection of environment. deep &Deep publications pvt. Ltd.
4. Handa, A K R H. Inder Dev, Rizvi, Naresh Kumar, Asha Ram, Dheeraj Kumar, Anil Kumar, S. Bhaskar, S K Dhyani and Javed Rizvi. 2019. Successful agroforestry models for different agro-ecological regions in India, New Delhi, India: World Agroforestry South Asia Regional Programme.

Reference books

1. Sinha, R. K. 2006. Sustainable agriculture. publisher: agro science book Centre ansari road, New Delhi.
2. Stephen R. gliessman. 2006. Multi scale integrated analysis of agro ecosystems –

46: 494 - 495. University of California. mariogiampietro. CRC press, 6000 broken sound parkway nw, suite 300,

3. Marian Stamp Dawkins and Roland Bonney 2008. Future of Animal Farmers, Blackwell Publishing. University of Oxford ICBN No.0781405177820

COURSE OUTCOME: Students will be able to use ecological principals to agroecosystem management.

FUNDAMENTALS OF ECOLOGY AND ENVIRONMENTAL SCIENCES

ECOL: 470 **CREDITS: 4**

COURSE OBJECTIVES: To introduce the basics of Ecology and Environmental Sciences to students coming from different background.

UNIT-I Introduction to Ecology & environmental sciences; Principles and Scope of Ecology Structure and Functions of Ecosystems- Abiotic and Biotic components, Flow of energy and cycling of materials; water, carbon, nitrogen and phosphorus, Trophic pyramids and food webs; Ecosystems Types and Diversity. **(10 Hours).**

UNIT-II Diversity of life; origin of life on earth and Speciation; Human Ecology and Human Settlements, Evolution of early life and changes in earth's atmosphere. Mendelian genetics –and Darwin Wallace theory of inheritance. Overview of Five kingdoms: Monera, Protists, Fungi, plant and animal kingdoms. **(10 Hours)**

UNIT-III Populations and communities; Birth, death and population size, age structure;Trends in human population growth; Malthusian growth. Intraspecific interactions and density dependence, Parasitism, Prey-predator relationships, Interspecific interactions; Commensalism, mutualism, competition and predation. Species diversity, community stability and disturbance **(10 Hours)**

UNIT-IV Aquatic and terrestrial communities; rare communities; deep earth, deep sea floor, volcanoes. Primary productivity; basic concepts, Ecological succession inland, water; concepts, Invasive species and control **(10 Hours)**

UNIT-V Practical and Field Experiments using standard methods; Estimation of density and relative abundance of species using quadrats and plotless methods. Estimation of species diversity: introduction to indices. Estimation of primary productivity. Ecological adaptations of the Plant and animal species in the hydrophytes, mesophytes and xerophytes. **(10 Hours)**

UNIT -VI Alterations of ecosystem function: Acid rain and its effect, nuclear winter and its types, global warming and its consequences, Ozone layer depletion, UN Climate Change Conference COP27 in 2022 and an overview of IPCC and Future prediction of Global warming **(10 hours)**

Text books:

1. Smith, TM and Smith RL 2015. Elements of Ecology, Pearson Education, India.
2. Cain, ML, Bowman, WD and Hacker SD 2011. Ecology, 2nd Edition, Sinauer Associates Inc.
3. Odum, E. P. (2004). Fundamentals of Ecology, Oxford and IBH Publishing Co. Pvt. Ltd.
4. Eugene P. Odum (2017). Ecology, 2nd Edition, Oxford and IBH Publishing Co. Pvt. Ltd.

Reference books:

1. Singh, J.S., S.P & Gupta, S.R. 2006. Ecology, Environment and Resource conservation. Anamaya Publ., New Delhi, 688 pp.
2. Miller. G.T. 2004. Environmental Science. Thomson, California. 538 pgs.
3. GT Miller, S Spoolman (2015). Environmental science. books.google.com
4. Chapman, J.L.& M.J. Reiss. 1998. Ecology: Principles and Applications. Cambridge Univ. press.2nd edition. 336 pgs.

5. Krebs, C.J. 2008. Ecology: The experimental Analysis of Distribution and Abundance
(6th Edition), Benjamin Cummings Publ. 688 pgs.
6. Charles J. Krebs (2013). Ecology: The Experimental Analysis of Distribution and Abundance: Pearson New International Edition. ISBN-13- 978-1292026275.
7. Thomas M. smith and Robert Leo Smith (2015). Elements of Ecology, Global Edition. Pearson. ISBN. 10:1-29207740-9.

COURSE OUTCOME: The students will understand the basics of Ecology & Environment

ECOLOGY OF URBAN ENVIRONMENT

ECOL 471 **CREDITS: 4**

COURSE OBJECTIVES: To examine the bio-physical processes of urbanization and how these influence the dynamics of urban populations, communities and ecosystems.

UNIT – I Introduction to urban ecology, urban environment and inherent ecological interest, testing ecological theory in urban environment, urban environment and human health and well-being, conserving biodiversity. **(10 Hours)**

UNIT – II Urban environments – Urbanization and primary biophysical processes, removalof vegetation, urban infrastructure, replacement of permeable with impermeable surfaces,destruction of aquatic areas. Urban forestry, potential benefits of urban forestry, contribution of urban forestry to sustainable development goals, designing urban forest, resilient cities and urbanforest. **(10 Hours)**

UNIT – III Community and ecosystem – level responses to urbanization – niche theories inurban ecology, habitat models, ecological guilds and resource competitions models, movement of individuals through space. Urbanization and carbon cycle, mitigation strategies, urbanization and water cycle. **(10 Hours)**

UNIT – IV Food security in Urbanizing World – Impacts of agriculture on biodiversity: habitat loss and fragmentation, water cycle, nutrients. Food systems in context of ecosystem services: Provisioning, supporting, regulating and cultural services. Case studies of Japan, Australia and Denmark. **(10 hours)**

UNIT – V Urban ecology of humans – Urban parks and open space, urban sprawl, neighborhood disorders, outdoor air pollution, indoor air pollution, health inequities in the cities. Peri-urban environment, peri-urban diversity and invasion. **(10 Hours)**

UNIT – VI Conserving biodiversity – Maintaining ecosystem services in cities, integrationof urban ecology and urban planning, protection of biodiverse landscape, green city, eco city, landscape connectivity, novel habitats and ecosystems. **(10 Hours)**

Text Books:

1. Kristen, MP, 2016. Ecology of Urban Environments, Wiley-Blackwell publications,USA.
2. Forman RTT, 2014. Urban Ecology: Science of Cities, Cambridge University Press,

Reference Books

1. Hall, P, 2020. Urban and Regional Planning 6th Ed. Taylor & Francis Ltd.
2. McCleery, RA, Moorman, CE, Peterson, MN, 2014. Urban Wildlife ConservationTheory and Practice, Springer Publisher.
3. Carreiro, MM, Song, YC, Wu, J., 2008. Ecology, planning, and management of Urbanforests, Springer Publishers.

COURSE OUTCOME: Understanding of the bio-physical processes of urbanization and influence of these processes on the dynamics of urban populations, communities, and ecosystems, understanding of the ecology of humans in cities. It also makes the students discuss the practical strategies for conserving biodiversity and maintaining ecosystem services in urban environments**.**

MANGROVE ECOSYSTEM

ECOL: 472 **CREDITS: 4**

COURSE OBJECTIVES: To understand the ecology of the mangrove ecosystem along with the threats and conservation aspects.

UNIT-I Mangroves: Introduction, evolution, occurrence, and distribution. Floristic composition of mangroves. True mangroves and mangrove associates. Zonation pattern in mangroves. Distribution Global: Tropical America, Africa, Asia, Southern Australia, and New South Wales; India: Sundarbans, Bhitarkanika, Coringa, Pichavaram, Palk Bay, Gulf of Mannar, Gulf of Kutchh, Andaman and Nicobar Islands, Lakshadweep Islands. Indo-west Pacific mangroves. Mangroves: regional variation along the Indian coast. Endemism. Genetic diversity of mangroves **(10 Hours)**

UNIT-II Morphological adaptations in mangroves. Root architecture (Pneumatophores, knee roots, stilt roots, etc.) Anatomy of root, wood, and leaf. Salt regulation physiology. Reproduction, dispersal, and establishment. Biomass and litter production. Metabolism in anaerobic environment. Inorganic nutrients (Nitrogen and Phosphorus): Nutrient uptake and recycling in mangroves. **(10 Hours)**

UNIT-III Primary producers (mangroves, cyanobacteria, diatoms, seaweeds, and seagrasses) in mangrove ecosystem. Diversity of seaweeds, seagrasses and diatoms in mangroves. Carbon cycling and storage in mangrove ecosystem. Mangroves as a major source of dissolved organic carbon. Blue Carbon and Climate change mitigation. **(10 Hours)**

UNIT-IV Fauna of mangrove ecosystem: Zooplankton, insects, Butterfly, mollusks, crustaceans, mangrove crabs, fiddler crabs, Telescopium, fish, mud skippers, crocodiles, turtles, birds and monitor lizards, and Bengal Tiger. Food chain and Food web in mangrove ecosystem and energy fluxes. Benthos: macrofauna and meiofauna, Spatio-temporal variation, vertical distribution, Redox-potential discontinuity, oxybios, and thiobios. Epibiosis of flora and fauna on mangrove roots and their endemism. Sulfide and tannins toxicity in mangrove fauna (**10 Hours)**

UNIT-V Economic and ecological value of mangrove ecosystem. Phytochemicals and pharmaceutical value. Production of Ichthyotoxic compounds (Heritonin, Heritol, etc.) by mangroves. Bioturbation and mangrove crab as an ecosystem engineer. loss of species: mangrove extinction risk and geographic areas of global concern. Global status and Indian status. Plantation programs around the world including India. Various threats to the mangrove ecosystem (natural and anthropogenic). Climate change and mangroves. Effect of pollution on mangroves. Conservation and management of mangroves. Sustainable use of mangrove resources. **(10 Hours)**

UNIT-VI Ecological investigations in a mangrove habitat. Differences in ecological parameters between mangrove and non-mangrove habitat. Line-transect and Quadrat method. Identification of common mangroves. Standing crop quantification of litter. Methodology to study microphytobenthos, macrofauna and meiofauna from mangrove sediments. Phytoplankton quantification and enumeration. Investigation on epibiosis on different mangrove structures (roots, leaves, trunk). **(10 Hours)**

Text Books

1. Molony, Brett, and Marcus Sheaves. Mangroves: ecology of intertidal forests. James Cook University of North Queensland, 1995.

2. Nybakkan J.N. (1997). Marine Biology-An ecological approach. Additon Wesley, Educational publication Inc.

Reference Books

1. Naskar, Kumudranjan, and Rathindranath Mandal. Ecology and biodiversity of Indian mangroves. Vol. 1. Daya Books, 1999.
2. Kathiresan K, Qasim SZ (2005) Biodiversity of mangrove ecosystems. Hindustan Publishing Corporation, New Delhi, India.
3. Hogarth, P. J. (2015). The biology of mangroves and seagrasses. Oxford University Press.
4. De Lacerda, L. D., & Linneweber, V. (2002). Mangrove ecosystems: function and management. Springer Science & Business Media.
5. Goldstein, M. I., & DellaSala, D. A. (2020). Encyclopedia of the World's Biomes. Elsevier.

COURSE OUTCOME: Students will acquire knowledge on the biology of mangroves, associated biodiversity and bio resource potential and their management.