Academic Council Meeting No. and Date: 8 / September 04, 2023

Agenda Number: 2 Resolution Number: 34, 35/2.18 & 2.39

Vidya Prasarak Mandal's

B. N. Bandodkar College of Science (Autonomous), Thane

Syllabus for

Programme: Master of Science

Specific Programme:

BIODIVERSITY WILDLIFE CONSERVATION & MANAGEMENT

[BWCM]

[M.Sc. (Semester I and II)]

Level 6.0

CHOICE BASED GRADING SYSTEM

Revised under NEP and Autonomy

From academic year 2023-24

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Sr. no	Heading	Particulars
1	**Title of the course**	**M.Sc. in Biodiversity, Wildlife Conservation and Management**
2	**Eligibility for Admission**	● B.Sc. in ANY subject or its equivalent. ● B.Sc. Veterinary science or its equivalent. ● B.Sc. Agriculture or Forestry or its equivalent
3	**Passing Marks**	**40%**
4	**No of Years/Semesters**	**Two years, Four semesters**
5	**Level**	**P.G.**
6	**Pattern**	**Semester**
7	**Status**	**Revised under Autonomy as per NEP 2020**
8	**To be Implemented from Academic Year**	**2023-24**
9	**Name & Sign of BOS Chairperson /Coordinator** **Department of Biodiversity, Wildlife Conservation and Management**	**Dr. Sandhya Pawale**

B. N. Bandodkar College of Science, (AUTONOMOUS)-Thane

Master program in Biodiversity, Wildlife Conservation and Management

Year (2 Yrs)	LEVEL	SEMESTER	Major				Research Methodology	On Job Training / Field project	Research project	Cum Credits	Degrees
			Mandatory		Electives anyone						
I	6.0	SEM-I	**3*4 + 2 = 14**		Credits 4		**Credits 4**	NA	NA	22	PG Diploma in Biodiversity, Wildlife Conservation and Management (After 3 Yrs. degree UG)
			Course 1	Credits 4	Course 1= Credits 4						
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2 = Credits 4						
			Course 4	Credits 2	**OR**						
		SEM-II	Course 1	Credits 4	Course 1 = Credits 4		NA	**Credits 4**	NA	**22**	
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2 = Credits 4						
			Course 4	Credits 2	**OR**						
Cum Cr.for 1 Yr. PG Diploma			**28**		8		4	4		44	
II	6.5	SEM- III	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 4**	22	Master program in Biodiversity, Wildlife Conservation and Management (After 3 Yrs. degree UG)
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
			Course 4	Credits 2	**OR**						
		SEM IV	Course 1	Credits 4	Course 1	Credits 4	NA	NA	**Credits 6**	**22**	
			Course 2	Credits 4	**OR**						
			Course 3	Credits 4	Course 2	Credits 4					
					OR						
Cum Cr. for integrated 1 Yr. PG Degree			**26**		**8**				**10**	**44**	
Cum Cr. for 2 Yr. PG Degree			**44**		**16**		**4**	**4**	**10**	**88**	

PREAMBLE

The potential source of income for the nation is its biodiversity, which is woefully underutilized. The shortage of skilled laborers is one of the causes of underutilization. Taxonomists and ecologists who prefer the field and functional and molecular biologists who prefer the lab make up the majority of the current generation of biologists. This gap has grown to be a barrier to understanding biodiversity. By concurrently encouraging expertise in field and lab biology, the current approach aims to close the gap. This capacity-building activity will contribute to the creation of wealth through making responsible and sustainable use of the nation's bio resources. The two-year postgraduate program M. Sc. Biodiversity Wildlife Conservation and Management consists of four semesters. The vitally important subject of biodiversity is covered comprehensively in the syllabus proposed below.

The course is divided into four semesters: the first year, which consists of two semesters, is heavily focused on the field, while the second year is focused on the lab as well as field.

First semester consists of ecology and plant and animal diversity. Second semester focuses on conservation biology which is a need of an hour. It will help students become a competent naturalist and ecologist because they place equal emphasis on conceptual and empirical knowledge of how natural systems function.

Third and Fourth semester comprises crucial topics like study of ecotourism, acts and laws of environment and wildlife, environmental journalism etc. It will expose students to apply and utilize the knowledge gained in the first year of the course and learn some new techniques for future use.

Eligibility:

- B.Sc in ANY subject or its equivalent.
- B.Sc. Veterinary Science or its equivalent.
- B.Sc. Agriculture OR Forestry or its equivalent.

Mode of Conduct: Laboratory practicals / Offline lectures / Online lectures

Program Specific Outcome:
On completion of the program, the student will be able to -

1 Perform field and laboratory research for biodiversity monitoring, conservation, and policy input.
2 Understand and explain the scientific process as related to conservation biology, including the relevance of theories and how hypotheses are tested.
3 Apply general ecological principles to assess and address conservation threats to particular species, communities, and ecosystems.
4 Investigate and communicate the connections between the biological and social sciences and humanities as they affect conservation programs and activities.
5 Identify, interpret, and communicate conservation ideas, needs and programs to others.

Dr. Sandhya Pawale
BOS Chairperson

VPM's B. N. Bandodkar College of Science (Autonomous), Thane
M.Sc. in Biodiversity, Wildlife Conservation and Management
Structure of Programme

Class	Sem	Course type	Course Code	Course Title	Credits
Part 1	SEMESTER 1	MAJOR	23BPBW1T1	Basics of Plant and Animal Diversity	4
			23BPBW1T2	Fundamentals of Ecology and Ecosystems	4
			23BPBW1T3	Essentials of Field study	4
			23BPBW1P1	Practicals	2
		ELECTIVE	23BPBW1T4	Adaptations	2
			23BPBW1P2	Practicals	2
			OR		
			23BPBW1T5	Agricultural Diversity	2
			23BPBW1P3	Practicals	2
			23BPRM1T6	Research Methodology	4
				Total	22
	SEMESTER 2	MAJOR	23BPBW2T1	Population dynamics & Behavioral Ecology	4
			23BPBW2T2	Habitat Ecology	4
			23BPBW2T3	Implementing Conservation	4
			23BPBW2P1	Practicals	2
		ELECTIVE	23BPBW2T4	Bioanalytical techniques	2
			23BPBW2P2	Practicals	2
			OR		
			23BPBW2P5	Evolution	2
			23BPBW2P3	Practicals	2
			23BPBW2P4	On-job Training / Field project	4
				Total	22
TOTAL SEM 1 & SEM 2					44

NOTE:

- In teaching learning case study need to illustrate wherever required.
- Current scenario should be collaborated with the syllabus
- Field visits to nearby zoo, museum/forest/sea- shore/ nursery/ aquaria/ or any other relevant site. The report of these visits will be submitted as part of the practical work.

SEMESTER I
MAJOR

Course Code 23BPBW1T1	Course Title Basics of Plant and Animal Diversity	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

- identify, classify and discuss the economic importance of lower and higher plants.
- classify angiospermic plants based on morphological structures
- identify & classify invertebrate and vertebrate animals.

Unit I:	**Introduction to Plant Pioneers**	**15**
	• Classification of Algae and Fungi (G. M. Smith) • Classification of Bryophytes (G. M. Smith) • Classification of Pteridophytes (G. M. Smith) (classification up to major groups)	
Unit II:	**Taxonomy of Seed Plants**	**15**
	• Classification of Gymnosperms (Chamberlain) • Classification of Angiosperms (Bentham & Hooker) • Basics of angiosperm morphology: Types of leaf, flower, fruit, seed • Angiosperm morphology: Arrangement - phyllotaxy, aestivation, placentation, other modifications • Major families – Magnoliaceae, Rhamnaceae, Myrtaceae, Combretaceae, Umbelliferae, Asteraceae, Labiateae, Euphorbiaceae, Orchidaceae (classification up to major groups)	
Unit III:	**Basics of Non-chordate Taxonomy**	**15**
	• Classification of Protozoans • Classification of Non-chordates (major phyla up to classes) • Phylum: Porifera, Coelenterata, Platyhelminthes • Phylum: Nematoda, Annelida, Arthropoda • Phylum: Mollusca, Echinodermata	

Unit IV:	**Basics of Chordate Taxonomy**	**15**
	• Classification of Protochordates and Chordates (up to major orders) • Phylum: Hemichordata, Urochordata, Cephalochordata • Phylum: Cyclostomata. and Chondrichthyes. • Phylum: Osteichthyes and Amphibia. • Phylum: Reptilia and Aves. • Phylum: Mammalia.	

Course Code 23BPBW1T2	Course Title Fundamentals of Ecology & Ecosystems	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

- Learn about certain species' roles in an ecosystem.
- Understand the basics of biodiversity in an ecological context
- Recognize the major biomes and outline their characteristics.
- Identify different types of biodiversity hotspots.
- discuss the role of biodiversity of freshwater, coastal and marine ecosystems.
- appreciate the role that biodiversity elements play in providing livelihoods to the coastal communities.
- demonstrate the impact of aquatic, grassland and forest areas on biodiversity.

Unit I:	**Fundamentals of Ecology & Biodiversity**	**15**
	• Concept of Ecology, Biotic & Abiotic factors • Species, Populations, Communities, Ecosystems, Ecological succession, Energy flow • Climatic Zones and Biodiversity - Global & Indian • Biodiversity - Concept & Types • Vegetation Types: Tropical Evergreen, Deciduous, Dry Deciduous, Desert, Tidal and Mountain Forests. • Phytogeographic & Zoogeographic Realms: Palearctic Realm, Nearctic Realm, Neotropical Realm, Ethiopian Realm, Oriental Realm, Australian Realm.	
Unit II:	**Biomes**	**15**
	• Concept of biomes • Biomes of the world • Biomes of India • Characteristic flora and fauna in each biome • Hotspots - Global and Indian	
Unit III:	**Freshwater, Coastal & Marine: Biodiversity & Management**	**15**
	• Zonation of the lake, river, sea and related distribution of species • Diversity of intertidal zones, mangroves, swamps, wetlands • Overexploitation of marine resources, bycatch and discards • Protected marine areas in India • Endangered species of freshwater, coastal and marine ecosystems • Threats to freshwater and marine biodiversity	

Unit IV:	**Forest and Grassland: Biodiversity & Management**	**15**
	● Diversity in Forest and Grassland ● Importance of Forest and Grassland Ecosystems ● Significance of managing forest and grassland ● Threats (overpopulation, deforestation, agricultural activities, wastelands, wildfires)	

Course Code 23BPBW1T3	Course Title Essentials of Field study	Credits 04	No. of lectures 60

Course Outcomes:

At the end of the course students will be able to:

- Understand key scientific concepts for species and ecosystem conservation.
- conduct a threat assessment for a site.
- execute field study by using field kits.
- understand the ethics in field studies.
- use appropriate software for modeling to predict and compute response
- examine animal tracks and signs to interpret their behavior

Unit I:	**Field surveys & Field Ethics**	**15**
	• Sampling methods and identifying study sites • Techniques of field observation Camouflages & observation stations • Non-intruding / non-interfering techniques of field observations • Methods of observing and recording animal behaviors • Sampling Behaviors, methods of observing Behavior; • Time- activity budgets, Ethograms, Social interaction matrices and their analysis • Ethics in Field Studies • Regulatory permissions for field observations	
Unit II:	**Recording & Evaluation of Data**	**15**
	• Qualitative & Quantitative data • Field note book and its records • Field kit and its usage • Cameras, binoculars, field scopes, camera traps, cellphones, etc. • Different methods of recording field observations, field traps. • Field collections & preservations	
Unit III:	**Analysis of animal tracks & signs (General concepts)**	**15**
	• Tracking large mammals • Studying & analyzing animal tracks & signs • Scat analysis and evaluation of food, feeding and health • Enumeration using tracks & signs, nest census	

Unit IV:	**Modeling techniques**	**15**
	• Various software platforms for modeling • Analytical models & simulations • Collecting data for modeling • Applications of modeling • Basic understanding of Remote sensing and GIS techniques and their applications	

Course Code 23BPBW1P1	PRACTICALS	Credits 02	No. of lectures 60

1. Using photographs / paintings / coloured drawings identify and study the classification & characteristics (representative species only) from;
    - Protista – protozoans
    - Non-chordates – Porifera to Hemichordata - upto classes
    - Insecta – Orthoptera, Coleoptera, Lepidoptera, Hymenoptera, Diptera, Odonata
    - Pisces – Agnatha, Chondrichthyes, Osteichthyes,
    - Amphibia – Anura, Gymnophiona and Urodela
    - Reptilia – Chelonia (Testudinia), Squamata, Crocodilia
    - Aves – Passeriformes, Anseriformes, Falconiformes, Struthioniformes, Galliformes, Psittaciformes, Strigiformes, Columbiformes, Ciconiformes,
    - Mammalia – Proboscidea, Sirenia, Primates, Rodentia, Chiroptera, Perissodactyla, Artiyodactyla, Pholidota, Carnivora

2. Using photographs / paintings / coloured drawings identify and study the classification & characteristics (representative species only) from;
    - Monera – bacteria, cynobacteria, spirochetes
    - Algae – Chlorophyta, Rhodophyta, Phaeophyta, Cyanophyta: Study of different fresh water and marine algae; common species only.
    - Fungi (upto orders) – molds, mushrooms, yeasts, mildews, smuts
    - mosses, ferns, gymnosperms

3. Study of morphology of plants (use photographs / paintings / coloured drawings / preserved specimen/ herbarium / in field);
    Leaf – morphology, modifications and phyllotaxy
    Flower – morphology & modifications
    floral formula (*Hibiscus* & *Pancratium*)
    Fruit – types & its morphology
    Seed – types, morphology and modifications for dispersal

4. Description of morphological characters of Angiosperm families prescribed in theory

5. Separate and identify different foraminifera from sand samples.

6. Estimation of stomatal index in leaves (at least three different leaf types representing at least two different micro-climatic conditions e.g. sun loving, shade loving).

7. Uv-Visible spectrophotometer scan of extracted plant pigments; spinach leaves, marigold petals and *Tradescantia* leaves. Evaluate the spectral characteristics.

	8. Study of some pioneer communities in succession; Lichen and their types, mosses and their types, coral and their types. 9. Using photographs / paintings / colored drawings identify and study ecological roles of characteristic plant & animal species (major representative species only) of various Biomes. 10. Using suitable diagrams / pictures identify zonations in a pond, sea-shore, forest and grassland ecosystem and study the species distribution. 11. Construct a habitat model of grassland/wetland/forest - evergreen, deciduous, dry/desert/aquatic 12. Application of transects and quadrants in simulated pictures / photographic sheets for data collection. Record & tabulate the data. 13. Instruments for sampling; water sampling bottles, plankton samplers, core samplers, bottom samplers, air samplers – construction, working and application (photographs of specimens and diagrams). 14. Using Vernier calipers make morphological measurements of Specimens (Any insect / fish / bird etc.), Skull, scales of reptiles, Wing and wing feathers etc. and record morphological data. Make a report and evaluate parameters like age, sex, species characteristics, etc. 15. Estimate primary production using water samples from different aquatic habitats. 16. Preparation of herbaria using suitable invasive plant samples (spreading, drying, pressing and labeling)	

SEMESTER I
ELECTIVE I

Course Code 23BPBW1T5	Course Title Adaptations	Credits 02	No. of lectures 30
Course Outcomes: On completion of the course, the students will be able to – • Categorize plants and animals based on their adaptations • Determine the role of plant and animal modifications in varied conditions			
Unit I:	**Plant Adaptations**		**15**
	● Plant adaptations to water, light, temperature, salinity ● Adaptations for association between plants & animals ● Concept of photoperiodism and thermo-periodism in plants ● Seed dormancy		
Unit II:	**Animal adaptations**		**15**
	● Physiological Basis of Animal adaptations to water, temperature, salinity ● Deep sea & diving adaptations in animals ● Role of blubber in marine mammals ● Adaptations for association between animals Hibernation, aestivation ● Hypothalamo- Hypophyseal Axis and its role Pineal gland and its role		
Course Code 23BPBW1P2	**PRACTICALS**	**Credits 02**	
	1. Adaptations in hydrophytes: *Pistia* – offset & leaf; *Eichhornia* – leaf & petiole; *Nymphaea* – leaf & petiole 2. Adaptations in xerophytes: *Opuntia* – phylloclade; *Nerium* – leaf; *Casaurina* – leaf 3. Insectivorous plants: identification, morphological adaptations and ecological distribution. 4. Adaptations in animals: use pictures or photographs with suitable labels. 5. Identification and study of venomous & poisonous plants and animals, action of their venom - Stinging nettle, *Mucuna pruriens*, Physalia, scorpion, tarantula, honey-bee, *Conus*, scorpion fish First aid for snake bites - Cobra (spectacled & monocled), Common krait, Banded krait, Russell's Viper, Saw scaled Viper, Pit vipers (Bamboo, Green, Malabar)		

	6. Visit to seed bank 7. Nature trail to study plant and animal adaptations 8. Resin art making of plant species	

SEMESTER I
ELECTIVE II

Course Code 23BPBW1T6	Course Title Agricultural Diversity	Credits 04	No. of lectures 30

Course Outcomes:
On completion of the course, the students will be able to –

- categorize wildlife diseases and associate its impact on flora and fauna.
- implement reliable and recent techniques and technologies for conservation in agriculture

Unit I:	**Wildlife diseases**	**15**
	• Major diseases (Plant & Animal) and their control • Domestic animals & wildlife diseases • Governmental role in control of wildlife diseases • Sick animal refuges in protected areas	
Unit II:	**Agricultural conservation**	**15**
	• Conserving indigenous agricultural species • Conservation of Live Stock species /varieties • Conservation of economically important aquatic species • Significance of gene banks, seed banks and germplasm conservation • Use of wild species for producing improved hybrid varieties Artificial seeds in conservation	

Course Code 23BPBW1P3	PRACTICALS	Credits 02
	1. Identification of plant diseases (Plant diseases: Powdery Mildew, Tobacco mosaic virus, leaf spot, canker) 2. Identification of Animal diseases (Animal diseases: Lumpy, Pruritus, Rabies, Botulism) 3. Artificial pollination techniques (emasculation, pollen harvesting, bagging and tagging) 4. Prepare a biocomposting setup 5. Visit to aquaculture facility / agricultural and allied institute 6. Farm/orchard visit 7. Visit to local vegetable market for wild vegetables survey	

	8. Visit to animal rescue center / hospital 9. Visit to Goshala 10. Indigenous Crop Diversity (millets) 11. Training of angling techniques with fishing equipments	

Course Code 23BPRM1T6	Course Title Research Methodology	Credits 4	No. of lectures in hrs. 60

Course Outcomes:

1 To create awareness about various sites for literature review from digital and journal sources.

2. To understand primary, secondary data, copyrights, patents IPR ,trademarks etc

3. To know the scientific correlation of data. analysis, writing and presentation of scientific papers

4. To handle ethically and scientifically wildlife and laboratory specimens

Unit I	**Print: [5L]** Primary, Secondary and Tertiary sources. **Journals:** Journal abbreviations, abstracts, current titles, reviews, monographs, dictionaries, text-books, current contents, Introduction to Chemical Abstracts and Beilstein, Subject Index, Substance Index, Author Index, Formula Index, and other Indices with examples. **Digital: [5L]** Web sources, E-journals, Journal access, TOC alerts, Hot articles, Citation Index, Impact factor, H-index, E-consortium, UGC infonet, E-books, Internet discussion groups and communities, Blogs, preprint servers, Search engines, Scirus, Google Scholar, ChemIndustry, Wiki-databases, ChemSpider, Science Direct, SciFinder, Scopus. **Information Technology and Library Resources: [5L]** The Internet and World wide web, Internet resources for Chemistry, finding and citing published information.	**[15]**
Unit II	**DATA ANALYSIS [15L]** **The Investigative Approach:** Making and recording Measurements, SI units and their use, Scientific methods and design of experiments. **Analysis and Presentation of Data**: Descriptive statistics, choosing and using statistical tests, Chemometrics, Analysis of Variance (ANOVA), Correlation and regression, curve fitting, fitting of linear equations, simple linear cases, weighted linear case, analysis of residuals, general polynomial fitting, linearizing transformations, exponential function fit, r and its abuse, basic aspects of multiple linear regression analysis.	**[15]**
Unit III	**METHODS OF SCIENTIFIC RESEARCH AND WRITING SCIENTIFIC PAPERS [15L]** Reporting practical and project work, Writing literature surveys and Reviews, organizing a poster display, giving an oral presentation. **Writing Scientific Papers:** Justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, publications of Scientific work, writing ethics, avoiding plagiarism.	**[15]**

Unit IV	**INTRODUCTION TO SCIENTIFIC ENQUIRY AND ETHICS** History of Science - what is science? origins of science, trends in natural sciences Transition from natural history to enquiry based study in biology Philosophy of Science - general introduction, difference in discipline specific philosophy Social implications of research. Animal experimentation ethics Wildlife ethics Human experimentation ethics Ethics in Science and research - data fudging, plagiarism	**[15]**
	References: 1. Dean, J. R., Jones, A. M., Holmes, D., Reed, R., Weyers, J., & Jones, A., (2011), Practical skills in Chemistry, 2 nd Ed., Prentice Hall, Harlow. 2. Hibbert, D. B. & Gooding, J. J. (2006) Data Analysis for Chemistry Oxford University Press. 3. Topping, J., (1984) Errors of Observation and their Treatment 4 thEd., Chapman Hill, London. 4. Harris, D. C. (2007) Quantative Chemical Analysis 6th Ed., Freeman Chapters 3-5 5. Levie, R. De. (2001) How to use Excel in Analytical Chemistry and in general scientific data analysis Cambridge University Press. 6. Iltis, A. MacKay, D. (2020) The Oxford Handbook of Research Ethics, Oxford University Press	

SEMESTER II
MAJOR

Course Code 23BPBW2T1	Course Title Population Dynamics & Behavioral Ecology	Credits 04	No. of lectures 60

Course Outcomes:
On completion of the course, the student will be able to -

- Interpret central concepts in analysis of population dynamics
- Categorize deterministic and stochastic factors that influence population fluctuations
- Assess the behavioral peculiarities of animals

Unit I:	**Population dynamics**	**15**
	• Age & Sex distribution • Recruitment ratio & population sustenance (e.g. herbivores, fish & prawns) • Effect of natality, mortality & migration • Exponential & logistic growth curves, Survivorship curves, k & r selected species Interaction between populations; • Types of interactions Predator – prey interactions • Fluctuations in populations.	
Unit II:	**Plant – Animal interactions**	**15**
	• Shelter & Nesting by animals • Effect of grazing & browsing • Protection strategies of plants for sustaining populations • Obligate plant – animal dependence – e.g. Fig wasp, Orchid mantis.	
Unit III:	**Behavioral Ecology – I**	**15**
	• Biological clock • Behavior of embryos • Animal Communication • Sexual conflict and selection • Social behaviors and parental care • Kin selection, altruism, reciprocal altruism, Hamilton's rule • Experience, learning and motivation • Orientation	

Unit IV:	**Behavioral Ecology - II**	**15**
	● Definition & types of behaviors (including innate & learned). ● Cues / triggers to behavior, Optimal Foraging theory (OFT), Kohler experiment ● Competition and Predation, Commensalism, Parasitism, mutualism, amensalism ● Genetic basis of behavior Sociobiology ● Anti-predator defenses ● Facial expression ● Zoopharmacognosy (Self medicating behavior in animals)	

Course Code 23BPBW2T2	Course Title Habitat Ecology	Credits 04	No. of lectures 60

Course Outcomes:

On completion of the course, the student will be able to –

- distinguish the various habitats based on animal preferences & figure out habitat selection in animals.
- understand the value of ecosystems and different elements of Urban biodiversity.
- integrate wildlife habitat management to human sufficiency
- Describe the importance and role of ecosystem services

Unit I:	**Habitat selection in animals**	**15**
	• Concept of home range, familiar areas • Concept of niches, its realization & its continuity • Micro-habitats: fallen log, treetop-puddles etc. • Territoriality and habitat utilization in animals	
Unit II:	**Urban Biodiversity**	**15**
	• Biodiversity in cities & towns • Concept of opportunistic, Invasive, Indigenous and Exotic species • Strays and feral populations • Impact of human activities on urban biodiversity: e.g. Effect of plastic and mobile radiation • Conservation practices of Urban Biodiversity • Role & Maintenance of Avenue plantation in urban areas (plantation, transplantation, reasonable pruning)	
Unit III:	**Wildlife habitats and human welfare**	**15**
	• Concept of carrying capacity • Limiting factors in habitats • Improving carrying capacity in wildlife areas e.g. Wildlife management for Game hunting & Fishing • Biomimetics • The Economics of Ecosystem and Biodiversity (TEEB) • Biodiversity as an Economic resource and its consideration in the national economic plans	

Unit IV:	**Ecosystem Services**	**15**
	• Definition and Significance • Provisioning and Regulating Ecosystem services • Cultural and Supporting Ecosystem services • Evaluating Outstanding Universal Value of Ecosystems • Natural Heritage sites in India	

Course Code 23BPBW2T3	Course Title Planning and Implementing Conservation Programmes	Credits 04	No. of lectures 60

Course Outcomes:

On completion of the course, the student will be able to -

- Interpret the importance of wildlife parks & reserves
- Relate traditional knowledge and tribal culture to conservation
- recognize pioneer institutes in the field of wildlife conservation
- illustrate the role of government and non-governmental organization towards conservation

Unit I:	**Major protected areas & their importance**	**15**
	• Wildlife parks, wildlife reserves, privately owned wildlife reserves & Biosphere reserves • Concept of buffer zones, core areas, wildlife corridors • Single species / single habitat-based conservation programmes (e.g. Project tiger, Valley of flowers)	
Unit II:	**People and conservation**	**15**
	• Traditional knowledge: Ethnobiology & Ecosystem people • Traditions & cultures • Tribes of Andaman & Nicobar, Arunachal Women in conservation • Traditional societies (e.g. Bishnois)	
Unit III:	**Major institutes for conservation**	**15**
	• Important international conventions & treaties on nature & conservation India's role & contribution (including VISION 2040) • Ex- situ & in-situ conservation • Conservation breeding (e.g. Vulture, Pygmy hog, Gharial etc.) • Institutions and their role in conservation; Zoos, Botanical gardens, aquaria, natural history museums & collections • Zoological survey of India, Botanical survey of India, Wildlife Institute of India, Forest Research Institute, Survey of India, Central Marine Fisheries Research Institute, SACON	

Unit IV:	**Role of NGOs in conservation**	**15**
	• International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions - Paryavaran Dakshata Mandal, Hariyali, WWF, ATREE, BNHS, WTI, Kalpavriksha • Important NGO movements Chipko movement, Apiko movement, Narmada Bachao Andolan, Pani Panchayats, Seed Movement, Save Aarey movement • Recent organizations and movements	

Course Code 23BPBW2P1	PRACTICALS	Credits 02

1. On a phytogeographic map of India locate & demarcate major sanctuaries / national parks.
2. Mount and identify zooplankton (preserved samples may be used).
3. Study of deep sea and intertidal flora and their ecological role (pictures / diagrams only).
4. Study of animal architecture (photographs / diagram / abandoned specimen); Hive of honey bee, nest of paper wasp, nest of potter wasp, mount of termite, nests of weaver bird and bowerbird, sand martin bird.
5. Using photographs / paintings / colored drawings identify and study distribution and ecological role of common bivalves and gastropods that occur along a sea-shore.
6. Determination of LC50 of a suitable toxicant (e.g. CuSO4 / neem leaf extract) using a suitable model e.g. *Daphnia*, *Cyclops*, mosquito larvae, Chironomous larvae, rice weevil, Brine shrimp, *Lemna*). Compare two or more different toxicants and compare their lethality.
7. Collect an **abandoned** nest of a bird (made of twigs /grass preferably collected after the breeding season). e.g. Bulbul or Crow or Warbler. Carry out the following analysis; Record the weight of the nest. Gently separate the nesting material one by one and segregate them as per their lengths. Weight each length group separately and note their group total weights. Note down any cushioning material /artificial materials used. Make a frequency table of nesting material lengths & weights. Depict your observations using suitable statistical tools and evaluate your data. Make interpretations regarding preferences in nesting material.
8. Identify and study specifications & applications of various ringing & tagging devices (photographs or models or working models and diagrams).
9. Visit to an NGO/institute/field visit for macro photography.
10. Identification, biology & ecological role of following introduced species; *Parthenium*, *Eichhornea*, *Lantana camara.*
11. Visit to Natural heritage site
12. Visit to a Zoological park / National park / Wildlife sanctuary

SEMESTER II
ELECTIVE I

Course Code 23BPBW2T4	Course Title Bioanalytical techniques	Credits 02	No. of lectures 60

Course Outcomes:

On completion of the course, the student will be able to –

- apply tools and techniques of genomics and proteomics for taxonomy and conservation
- gain skill on operating PCR, HPTLC, DNA Sequencing, colorimeter and centrifuge
- learn the techniques of Electrophoresis & Chromatography

Unit I:	**Molecular Techniques – I**	**15**
	● Genomics (General concepts & applications) ● Extraction of DNA from samples ● PCR & RT PCR ● DNA sequencing, Sanger's & Maxam Gilbert methods, DNA fingerprinting, DNA barcoding ● Southern Blotting and its applications	
Unit II:	**Molecular Techniques – II**	**15**
	● Proteomics - General concepts & applications in phylogenetic analysis ● Extraction & evaluation of proteins ● Protein fingerprinting (e.g. venom proteins, plant proteins) Western Blotting and its applications ● Protein characterization (X-ray crystallography, Mass spectrometry)	

Course Code 23BPBW2P2	PRACTICALS	Credits 02
	1. Separate (serum / milk / pulses, etc.) proteins using PAGE and identify protein sizes using a protein ladder. 2. Extraction of DNA from a suitable mammalian blood / human cheek smear / Tissue or Plant sample (use kits / phenol-chloroform – isoamyl alcohol method / SDS – Ethanol method). Evaluate the purity of the extracted DNA with spectrophotometry. Comment on the results. 3. Extraction of RNA by Orcinol reagent. 4. Bioinformatics – using BLAST / FASTA tools, compare / analyze proteins 5. column chromatography 6. TLC 7. AGE 8. PCR 9. Blotting techniques	

SEMESTER II
ELECTIVE II

Course Code 23BPBW2T5	Course Title Evolution	Credits 02	No. of lectures 60
Course Outcomes: On completion of the course, the student will be able to – ● discuss the formation and development of major geological events of earth ● describe the various concepts and theories for evolution of life			
Unit I:	**Natural History**		**15**
	● Geological time scale ● Continental drift, plate tectonics ● Prehistoric migration and dispersal of species ● Extinction, extinction events ● Natural History of major Flora & Fauna of India ● Natural History of Western Ghats		
Unit II:	**Evolution**		**15**
	● Theories of Evolution: Early Theories, Darwin's Theory, Modern Synthesis, Origin and evolution of life across various eras, Mutation and variation Mutation-Selection balance. ● Hardy-Weinberg's Principle, Red Queen Hypothesis, Mechanism of Evolution (Genetic variation and recombination, Random genetic Drift, natural and sexual selection, Gene flow, Reproductive Isolation), Adaptation, Co-evolution, Speciation and its types: Allopatric and sympatric speciation with suitable examples, Neutral Mutation ● Linking evolution to ecological adaptations and Behavioral adaptations; Examples: Darwin's finches, Insular fauna including plants		

Course Code 23BPBW2P3	PRACTICAL	Credits 02
	1. Study of plant and animal fossils (Stromatolites, *Rhynia, Lepidodendron, Trilobite, Ammonite, Glomerula, Colombia forbesi*) 2. Study of plant and animal connecting links (*Archaeopterix*, Lungfish, Platypus, *Gnetum*, Seed ferns, *Euglena*) 3. Study of animal hybrids (grizzly, mule, wholphin, liger, zorse, dzo) 4. Making of fossils using shadu clay 5. Identify animals with super senses (Octopus, Bat, Mantis Shrimp, Jewel beetles, Honey Bees) 6. Study of homologous and analogous animal parts. 7. Visit to a museum/science center 8. Taxidermy workshop 9. Contribution of evolutionary biologists – Darwin, Wallace, Dawkins	

SUGGESTED READINGS

Sr. No.	Title	Author	Publisher	Year
1.	Protected Area Update; Newsletter	---------	Kalpavriksh Environment Action Group, Pune , India	Periodical
2.	Zoos in India; Legislation, Policy, Guidelines and Strategy	----------	Central Zoo Authority, New Delhi	2007
3.	Wildlife ecology	Aaron, N.M.	W.H. Freeman Co. San Francisco, U.S.A.	1973
4.	The Book of Indian Birds	Ali, Salim	Oxford University Press, Mumbai	1997
5.	Wildlife Ecology, Conservation and Management	Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly	Blackwell Publishing, U.S.A.	2006
6.	The Book of Indian Shells.	Apte, Deepak.	Oxford University Press, Mumbai.	
7.	Colorful Atlas on Indian Wildlife Diseases and Disorders	Arora and Bipul Chakraborthy B.M.	IBDC, Lucknow.	2008
8.	Indian Wildlife Yearbook	Arora B. M. , Editor	AIZ & WV, Bareilly and Central Zoo Authority, New Delhi	2002
9.	Dietary Husbandry of Wild Mammalia	Arora, B.M.	AIZ & WV, Bareilly and CZA, New Delhi.	2001
10.	Indian Wildlife Diseases and Disorders.	Arora, B.M.		
11.	Rehabilitation in free living wild animals	Arora, B.M.	AIZ & WV, Bareilly	2007
12.	Reproduction in Wild Mammalia & Conservation	Arora, B.M.	AIZ & WV, Bareilly.	2002
13.	A Text Book of Developmental Biology	Banerjee, S.	IBD, Dehradun	2001
14.	Remote Sensing for Hazard Monitoring and Disaster Assessment	Barett, E.C. and Anton Micallef	Taylor and Francis, London	1991
15.	Statistics in Research	Bernard Ostle and R.W.Mensing		
16.	Wild Animals in Central India	Brander, A.A	Natraj Publisher, Dehradun.	
17.	Method of Statistical Analysis	C.H. Goulden	John Wiley & Sons	
18.	Environmental Impact Assessment	Canter, L. W.	Graw, Mc, , Hill Publication, New York.	
19.	A TextBook of Agricultural Statistics	Chandel S.R.S,.	Achal Prakashan Mandir, Kanpur	1999

Sr. No.	Title	Author	Publisher	Year
20.	Introduction to Geographic Information Systems,	Chang – Kang, Tsung	Tata McGraw -Hill Publishing Company Limited, New Delhi	2002
21.	A guide to Chemical Restraint of Wild Animals.	Chowdhury, Sushant and Malik, Pradeep	Natraj Publishers, Dehradun.	
22.	EIA – A Biography	Clark, B. D., Bissel, B. D. and Watheam, P.	School of Forestry and Environment, SHIATS- Deemed University, Allahabad	
23.	The Temple Tiger.	Corbett, Jim	Oxford University Press, New Delhi	2007
24.	Asian Elephant,	Daniel, J.C.	Natraj Publishers, Dehradun	
25.	The Book of Indian Reptiles and Amphibians	Daniel, J.C.	Oxford University Press, Mumbai.	
26.	Resource and Environmental Economics	Fisher, A.C.	New York: John Wiley & Sons	1979
27.	The conservation of plant biodiversity.	Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J.	Cambridge University Press	1995
28.	Statistical Methods	G.W. Snedecor and W.G. Cochran		
29.	The Serengeti Lion	George B. Schaller		
30.	Fundamentals of Wildlife Management	Gopal, Rajesh	Justice Home, Allahabad, India.	1992
31.	Encyclopedia of mammals	Grzimek	McGraw Hill Publishing House, New Delhi.	1988
32.	Wild Animals, Their Minds and Manners	Hornaday, W.T.	IBD, Dehradun.	1989
33.	Concepts in Wildlife Management	Hosetti, B.B.	Daya Publishing House, Delhi.	1997
34.	Collection and preservation of animals	Jairajpuri M. S.	Zoological Survey of India	1990
35.	Statistical Ecology	John A. Ludwig & James F. Reynolds	John Wiley & Sons	1988
36.	Handbook of Environment, Forest and Wildlife Protection Laws in India	Justice Kuldip Singh	Natraj Publishers, Dehradun	1998
37.	Biodiversity conservation in managed and protected areas	Katwal/Banerjee	Agrobios, India	2002

Sr. No.	Title	Author	Publisher	Year
38.	Advances in Fish and Wildlife Ecology and Biology	Kaul, B.L.		1999
39.	A Vet in Wilderness	Khan Ali M. G.	Central Zoo Authority, New Delhi	
40.	Modern Textbook of Zoology, Vertebrates.	Kotpal, R.L.	Rastogi Publications, Merrut.	
41.	Remote Sensing and Image Interpretation	Lillesand, T.M. and Kieffer, R.W	John Wiley and Sons	
42.	Wild Animals of India, Burma, Malaya and Tibet	Lydekker, R.,	Natraj Publishers, Dehradun.	
43.	Wildlife Crime	Menon, Vivek and Kumar, Ashok	Natraj Publisher, Dehradun.	1999
44.	Wildlife Issues in a Changing World	Moulton, M. P. & J. Sanderson	St. Lucie Press	1997
45.	A handbook of forestry.	Negi, S.S.	International Book Distributor, Dehradun.	2005
46.	Biodiversity and its conservation in India	Negi, S.S.	Indus Publishing Co., New Delhi.	1993
47.	Manual for Wildlife Management in India	Negi, S.S.		
48.	Fundamentals of Ecology	Odum, Eugene P	Natraj Publishers, Dehradun.	
49.	Applied Anatomy of Domestic Animals.	Ommer, P.A. and Harshan, K.R.	Jaypee Brothers Medical Publishers (P) Ltd., New Delhi.	
50.	Natural Resource Information for Economic Development	Orris C. Herfindahl	Baltimore: The Johns Hopkins University Press	1969
51.	Watching and Conserving	Oxford Anthology of Indian Wildlife	Oxford University Press, New Delhi.	
52.	Aerial Photography and Image Interpretation for Resource Management.	Paine, D.P.	John Wiley and Sons.	
53.	The Ecology of Wildlife Diseases.	Peter J. Hudson, Annapaola Rizzoli, Bryan T. Grenfell, Hans Heestrbeek and Andy P. Dobson	Oxford University Press, Oxford	2002
54.	Book of Indian Animals.	Prater, S.H.	Bombay Natural History Society, Mumbai.	
55.	Essentials of Conservation Biology	Primack, R.B.	Sinauer Associates, Inc. Sunderland, MA	1998

Sr. No.	Title	Author	Publisher	Year
56.	Principles and Procedures of Statistics (with special reference to Biological Sciences)	R.G. Steel and J.H. Torrie		
57.	A TextBook of Agricultural Statistics	R.Rangaswamy		
58.	Birds of Wetlands and Grasslands	Rahmani, Asad R. & Ugra, Gayatri	Bombay Natural History Society, Mumbai.	
59.	A Handbook of the Management of Animals in Captivity.	Ram Brahma Sanyal		1995
60.	Hunting and Shooting	Rangarajan, Mahesh	The Oxford Anthology of Indian Wildlife.	1999
61.	The ecology and evolution of animal behavior	Robert, A.W	Good Year Pub. Co. California, U.S.A.	1979
62.	Wildlife management.	Robert, G.H.	W.H. Freeman and Co., San Francisco, U.S.A.	1978
63.	The Care and Feeding of Infant Orphaned Wild Birds.	S.M.L. Grose.	IBD, Dehradun	
64.	Remote Sensing: Principles and Applications	Sabbins, F.E., Freeman		
65.	Manual of wildlife techniques for India.	Sale, J.B. and Bergmuller, K.	WII, FAO, DehraDun, India	1988
66.	A Handbook of the Management of Animals in Captivity.	Sanyal, Ram Brahma		1995
67.	Indian Wildlife Resources Ecology and Development	Sharma, B.D	Daya Publishing House, Delhi	1999
68.	A New Approach to Linear Programming	Sharma, S.D.	Kedarnath, Ramnath and Co. Meerut	1975
69.	Wildlife Ecology, Conservation and Management	Sinclair, Anthony R.E., Fryxell, John M. and Caughey, Graeme	Blackwell Publishing, U.S.A.	2006
70.	Economics of PA's and its effect on biodiversity.	Singh and Vijaykumar.	APH Publishing Corporation, New Delhi.	2001
71.	Text Book of Wildlife Management.	Singh, S.K.	IBDC, Lucknow.	2005

Sr. No.	Title	Author	Publisher	Year
72.	Conserving India's Natural Heritage	Singh, Samar	Natraj Publication, DehraDun.	1987
73.	Wildlife and Forest Conservation	Sinha, P.C.	Anmol Publishing Pvt. Ltd., New Delhi.	1998
74.	Mammals Skin.	Sokolov, V.E.	IBD, Dehradun.	1982
75.	Wildlife research and management. Asian and American Approaches	Stephen, H.B. and V.B. Saharia	Oxford University Press, Delhi	1995
76.	Zoogeography of India and Asia.	Tiwari, S.K.	CBS Publisher and Distributors, New Delhi.	
77.	Natural Resource and Environmental Economics	Tony Prato,	Iowa State University Press	1998
78.	Environmental and social impact assessment	Vanclay F. and Bronstein, D.A.	John Wiley & Sons, New York.	1995
79.	Guide for Planning Wildlife Management in Protected Areas and Managed Landscapes	Vishwas Sawarkar	Natraj Publisher. Dehradun	
80.	Experimental Designs	W.G. Cochran and G.M.Cox		
81.	Parasitic Diseases of Wild Animals.	W.M. Samuel, M.J. Pybus and A.A. Kocan		2005
82.	Vertebrate Zoology and Evolution.	Yadav, B.N.	IBD, Dehradun.	2000
83.	On the Origin of Species	Charles Darwin		
84.	Invertebrates, Chordate Zoology	Jordan & Verma		
85.	Apala Paryavaran	Paryavaran Dakshata Mandal		

Evaluation Scheme 60:40
Internals Based on Unit 1 / Unit 2 / Unit 3/ Unit 4

Assignments/ Tutorials/Class Test	Seminar or any other activities	Ppt/video Presentation or any other activities	Group discussion/Book Review or any other activities	Active Participation & Leadership qualities	Total
10	10	10	05	05	40

Theory Examinations: For Paper 1, Paper 2, Paper 3 and Research Methodology
Suggested Format for MAJOR Question paper
Duration: 2½ Hours **Total Marks: 60**

- **All questions are compulsory**

Q. 1	Answer ***any two*** of the following-		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following-		**12**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Answer ***any two*** of the following-		**12**
	a	Based on Unit III	
	b	Based on Unit III	
	c	Based on Unit III	
	d	Based on Unit III	
Q. 4	Answer ***any two*** of the following-		
	a	Based on Unit IV	**12**
	b	Based on Unit IV	
	c	Based on Unit IV	
	d	Based on Unit IV	
Q. 5	Write a short note on ***any four*** of the following		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit II	
	d	Based on Unit II	
	e	Based on Unit III	
	f	Based on Unit III	
	g	Based on Unit IV	
	h	Based on Unit IV	

Theory Examinations: For ELECTIVE Paper

Duration: 1.0 Hours **Total Marks: 30**

- **All questions are compulsory**

Q. 1	Answer ***any two*** of the following-		**12**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit I	
	d	Based on Unit I	
Q. 2	Answer ***any two*** of the following-		**12**
	a	Based on Unit II	
	b	Based on Unit II	
	c	Based on Unit II	
	d	Based on Unit II	
Q. 3	Write a short note on ***any two*** of the following-		**06**
	a	Based on Unit I	
	b	Based on Unit I	
	c	Based on Unit II	
	d	Based on Unit II	

Semester End Practical Examination:

Practical examination of each paper for 50 marks will be held for three and half hours

Semester ____ Practical Examination "Month & Year"

Paper Code:- _____

Total Duration: - 03.½ hrs. **Total Marks**: - 50

Distribution of marks

Question 1 - (performance & result/identification) – 20 marks
Question 2 - (performance & result/identification) – 10 marks
Question 3 - (identification) – 10 marks
Question 4 - (viva voce) – 05 marks
Question 5 - (journal/field report) – 05 marks

(This is sample paper pattern for practical. It can be changed by the department/college as per the prescribed practical given in syllabus)

Marks Distribution and Passing Criterion for Each Semester

Theory						Practical		
Course Code SEMI / SEM II	Internal	Min marks for passing	Theory Examination	Min marks for passing	Total	Course Code	Practical Examination	Min marks for passing
23BPBW1T1/2T1	40	16	60	24	100	-	-	-
23BPBW1T2/2T2	40	16	60	24	100	-	-	-
23BPBW1T3/2T3	40	16	60	24	100	-	-	-
Laboratory 1	-	-	-	-	-	23BPBW1P1/ 2P1	**50**	**20**
23BPBW1T4 or 1T5/2T4 or 2T5	20	08	30	12	50			
Laboratory 2	-	-	-	-	-	23BPBW1P2 or 1P3/2P2 or 2P3	**50**	**20**
23BPRM1T6 / 23BPBW2P4	40	16	60	24	100	-	-	-

Pedagogy for student engagement is predominantly lectures. However, other pedagogies enhancing better student engagement to be recommended for each course. The list includes active learning/ course projects/ problem or project-based learning/case studies/self-study like seminar, term paper or MOOC

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