



પરિપત્ર:

ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટીની લાઈફ સાયન્સ વિદ્યાશાખાનાં અભ્યાસક્રમ ચલાવતી તમામ સંલગ્ન કોલેજોનાં આચાર્યશ્રીઓને સવિનય જણાવવાનું કે લાઈફ સાયન્સ વિદ્યાશાખા હેઠળનો NEP-૨૦૨૦ અંતર્ગત ઝૂલોજી વિષય સેમેસ્ટર-૫નો અભ્યાસક્રમ આ સાથે સામેલ છે.

માનનીય કુલપતિશ્રીની મંજૂરી અનુસાર સદર અભ્યાસક્રમ શૈક્ષણિક વર્ષ જુન, ૨૦૨૫ થી અમલવારી કરવાની રહે છે. લાઈફ સાયન્સ વિદ્યાશાખાનાં અભ્યાસક્રમ ચલાવતી તમામ સંલગ્ન કોલેજો ધ્વારા તેની અમલવારી કરવા જણાવવામાં આવે છે.

નોંધ: ઝૂલોજી વિષયનાં અભ્યાસ સમિતિનાં ચેરમેનશ્રી દ્વારા અત્રેની યુનિવર્સિટીને ઈમેઈલ દ્વારા ઝૂલોજી વિષયનાં અભ્યાસક્રમ ફેરફાર જણાવેલ જે મુજબ બીકેએનએમયુ/એકેડેમિક/૨૩૨/૨૦૨૫ તા.૦૩/૦૬/૨૦૨૫નાં પરિપત્રમાં ઝૂલોજી વિષયનાં અભ્યાસક્રમમાં ફેરફાર કરવામાં આવેલ છે.



[Signature]
૩૧/૦૬/૨૦૨૫

ખાસ ફરજ પરના અધિકારી
(એકેડેમિક)

ક્રમાંક/બીકેએનએમયુ/ એકેડેમિક/૫૧૬/૨૦૨૫

ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી,

સરકારી પોલીટેકનિક કેમ્પસ,

ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી રોડ,

ખડીયા, જૂનાગઢ-૩૬૨૨૬૩

તા.૦૭/૦૮/૨૦૨૫

પ્રતિ,

- ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી સંલગ્ન લાઈફ સાયન્સ વિદ્યાશાખાનાં અભ્યાસક્રમો ચલાવતી તમામ કોલેજોના આચાર્યશ્રીઓ તરફ....

નકલ સાદર રવાના:-

- માન.કુલપતિશ્રી/ કુલસચિવશ્રીનાં અંગત સચિવશ્રી.
- પરીક્ષા નિયામકશ્રી, ભક્તકવિ નરસિંહ મહેતા યુનિવર્સિટી, જૂનાગઢ

નકલ રવાના જાણ તથા યોગ્ય કાર્યવાહી અર્થે:

- સીસ્ટમ મેનેજરશ્રી, આઈ.ટી.સેલ વિભાગ (વેબસાઇટ ઉપર પ્રસિદ્ધ થવા અર્થે.)



BHAKTA KAVI NARSINH MEHTA UNIVERSITY
JUNAGADH



BOARD OF STUDIES

FACULTY OF LIFE SCIENCE

SYLLABUS FOR ZOOLOGY (HONOURS)

PROGRAMME (SEMESTER- V)

EFFECTIVE FROM JUNE, 2025

FORWARD

In academics, syllabus serves as a roadmap for teaching various topics in a well-defined manner. Along with constant changes in the field of subject, it is always required to review and update the syllabus so as to meet changing scenario at regional, national and global levels. In science, higher education at degree level creates base for students to sharpen their skills and enable them for securing employment. Moreover, for a few this also opens a new realm of research and education at post-graduation level. Hence, finalizing degree level syllabus requires to keep all these facts in mind.

The NEP 2020 states, “Assessments of educational approaches in undergraduate education that integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) have consistently shown positive learning outcomes, including increased creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning”.

Here, the current syllabus is finalized after elaborate discussions amongst well qualified and experienced teachers. The syllabus is prepared according to the guidelines of UGC under NEP 2020. We delighted to share the curriculum and credit framework for B.Sc. Zoology Sem-5. The present syllabus encompasses latest trends in the subject. We are hopeful that students will be able to enhance their knowledge and understating of the subject well.

Board of Studies, Zoology
Bhakta Kavi Narsinh Mehta University,
Junagadh – 362 001

INDEX

No.	Content		Page No.
1	Summary of the Syllabus Sem-5		
2	Pattern of Examination Sem-5		1
3	Course structure and syllabus		
SEMESTER-V	Major-11	Course details, objectives and outcomes	2
		Course content	3
		Reference Books	4
	Major-12	Course details, objectives and outcomes	6
		Course content	7
		Reference Books	7
	Major-13	Course details, objectives and outcomes	9
		Course content	10
		Reference Books	11
	Minor-4	Course details, objectives and outcomes	12
		Course content	13
		Reference Books	14
	Minor-5	Course details, objectives and outcomes	15
		Course content	15
		Reference Books	16
4	Examination Paper style		
	Theory Examination Paper Style : Major- 11/12; Minor-4		17
	Practical Examination Paper Style : Major- 13		18
	Practical Examination Paper Style : Minor-05		19

BHAKTA KAVI NARSINH MEHTA UNIVERSITY

Major/Minor

Syllabus of B.Sc. (Honors) as per NEP-2020

Faculty of Lifesciences

Effective from June 2025

Subject: Zoology

SEMESTER- V

SUMMARY OF THE SYLLABUS

Sem. No.	Sr. No.	Category of Course	Course Title	Course Level	Credit	Teaching Hrs.	SEE Marks	CCE Marks	Total Marks	Exam Duration
5	1	Major-11	Zoology in Indian Knowledge Systems and Evolutionary Biology	5.5	4	60 Hrs.	50	50	100	2:00 Hrs.
	2	Major-12	Chordates-III and physiology	5.5	4	60 Hrs.	50	50	100	2:00 Hrs.
	3	Major-13	Zoology in Indian Knowledge Systems, Evolutionary Biology, Chordates-III and physiology	5.5	4	120 Hrs.	50	50	100	4:00 Hrs.
	4	Minor-4	Environmental science, wildlife population sampling and biostatistics	5.5	4	60 Hrs.	50	50	100	2:00 Hrs.
	5	Minor-5	Practical: Environmental science, wildlife population sampling and biostatistics	5.5	4	120 Hrs.	50	50	100	4:00 Hrs.
				Total	20					

Pattern of Examination for Major-11/12 & Minor-4

EVALUATION OF 100 MARKS (4 CREDIT PAPER)

Continuous and Comprehensive Evaluation (CCE)-50 Marks		Semester End Evaluation (SEE)-50 Marks
Mid Semester Exam (Mandatory)-25 Marks	1. Class assignment -- 05 2. Home assignment -- 05 3. Field assignment -- 05 4. Viva/Oral exam -- 05 5. Attendance -- 05	Semester End Theory Examination 50 Marks
Total 25 Marks	Total 25 Marks	Total 50 Marks

Pattern of Examination for Major-13 & Minor-5

EVALUATION OF 100 MARKS (4 CREDIT PAPER-PRACTICAL BASED)

Continuous and Comprehensive Evaluation (CCE)-50 Marks		Semester End Evaluation (SEE)-50 Marks
Mid Semester Exam (Mandatory)-25 Marks	1. Class assignment -- 05 2. Home assignment -- 05 3. Field assignment -- 05 4. Viva/Oral exam -- 05 5. Attendance -- 05	Semester End Practical Examination 50 Marks
Total 25 Marks	Total 25 Marks	Total 50 Marks

Course Level	5.5	Internal Marks	50
Programme	Zoology	External Marks	50
Semester	V	Practical Internal	--
Category of Course	Discipline Specific Major Courses (Major-11)	Practical External	--
Course Credit	04	Prac. External Exam Duration	--
Teaching Hours	60	Total	100
Course Code		Exam Duration	2.0 hrs
Course Title	Zoology in Indian Knowledge Systems and Evolutionary Biology		

Course Objectives: This course aims to:

- Introduce IKS principles and their relevance to understanding animals.
- Explore animal perception, use, and symbolism in ancient India.
- Analyse early IKS ecological understanding and traditional animal knowledge.
- Investigate early animal physiology insights, veterinary practices and animal conservation.
- Understand evolutionary biology's core principles: Earth's geological history, species distribution patterns, and mechanisms of evolution and speciation.

Course Learning Outcomes: After completion of the course students will be able to:

- Explain IKS principles related to animals and analyze their cultural significance.
- Analyse early IKS ecological concepts and traditional animal behaviour knowledge.
- Describe early IKS insights into animal physiology and traditional veterinary practices.
- Evaluate IKS ethical foundations and traditional practices for animal conservation.
- Students will explain the geological time scale's major epochs and analyze how zoogeographical realms and dispersal barriers affect life's distribution and evolution.

Course Contents

Sem.	Unit No.	Syllabi	Teaching Hours
5	1	Introduction to IKS and Animals in Ancient Indian Culture, Agriculture and Warfare 1.1 Introduction to IKS: Definition, scope, historical overview, Overview of Ancient Indian Texts: Vedas, Upanishads & Aranyakas, Arthashastra; Vrikshayurveda, Panchatantra etc. 1.2 Animals in Ancient Indian Culture and Symbolism: Deities, mythical creatures (Hindu, Buddhist, Jain); <i>Vahanas</i> (symbolic mounts); portrayal in art, sculpture, literature; role in rituals, ceremonies, and festivals related to specific animals. 1.3 Use of Animals in Ancient Indian Agriculture and warfare: Use of cattle and other animals in agriculture; traditional animal husbandry; seasonal agricultural practices and festivals involving cattle; use of elephants and horses in war.	15
	2	Animal Ecology and Behavior 2.1 Early Ecological Understanding in IKS: Rta (cosmic order) and ecological balance; interconnectedness in Vedic/Upanishadic thought; Panchabhutas (five Elements); Rituchakra (Seasonal cycles and its impact on animal life). 2.2 Behavior and Ecology: Observations in literature, folklore, folksongs, art; cultural/mythological significance (ecological/behavioral); early animal welfare concepts 2.3 Traditional Knowledge of Animal Behavior and Habitats: Knowledge of animal behavior and habitats in various communities; Astronomy and its observations of animal behavior; Mathematics and its role in understanding biological ratios and patterns.	15
	3	Animal Physiology, Veterinary Practices and conservation 3.1 Ayurvedic perspectives on animal physiology: References in Ayurveda/other texts; Concept of Tridosha; Ayurvedic views on digestion, respiration, circulation. 3.2 Traditional Veterinary Practices: Ancient texts (<i>Ashvashastra</i> , <i>Gajashastra</i>); traditional diagnosis/treatment; herbal/natural remedies; 3.3 Animal Conservation in IKS: Sacred groves (biodiversity); cultural narratives fostering protection (reflected in	15

		folksongs and stories); Sustainable hunting/fishing (seasonal restrictions reflected in traditions), Present role of zoologist in society	
	4	Evolutionary Biology 4.1 Geological time scale: Eras, periods, and epochs of Earth's history 4.2 Zoogeography: Zoogeographical realms, Life on Islands, Wallacea. 4.3 Geographical distributions and barriers: Kinds of distributions, necessity of dispersal, barriers to dispersal. 4.4 Macro and microevolution: evolutionary mechanisms. 4.5 Speciation: Causes, mechanisms, and types (allopatric, peripatric, parapatric, sympatric).	15

Suggested Reading:**Unit I: Introduction to IKS and Animals in Ancient Indian Culture, Agriculture, and Warfare**

1. Outlines of Indian Philosophy -- M. Hiriyanna -- Motilal Banarsidass Publishers
2. Translations of the Vedas -- Ralph T.H. Griffith, Wendy Doniger -- Penguin Classics
3. Translations of key Upanishads -- Swami Prabhavananda and Frederick Manchester, Eknath Easwaran -- Penguin Classics, Oxford University Press
4. Arthashastra -- Kautilya -- R. Shamasastri, L.N. Rangarajan -- Penguin Classics, Oxford University Press
5. Translations of the Ramayana -- R.K. Narayan, William Buck -- Penguin Classics
6. Translations of the Mahabharata -- Kisari Mohan Ganguli, John D. Smith -- Penguin Classics, University of Chicago Press
7. Translations of the Panchatantra -- Arthur W. Ryder, Chandra Rajan -- Penguin Classics
8. Myths and Symbols in Indian Art and Civilization -- Heinrich Zimmer -- Princeton University Press
9. History of Agriculture in India, Vol. 1 -- K.L. Mehra -- Indian Council of Agricultural Research
10. The Art of War in Ancient India -- P.C. Chakravarti -- D.C. Law Trust
11. Warfare in Ancient India -- G.P. Singh -- Atlantic Publishers & Distributors

Unit II: Animal Ecology and Behaviour

12. Glimpses of Indian Ethnobotany -- S.K. Jain (Ed.) -- Oxford & IBH Publishing Co.
13. Astronomical Code of the Rigveda -- Subhash Kak -- Aditya Prakashan
14. History of Hindu Mathematics -- B. Datta and A.N. Singh -- Motilal Banarsidass Publishers

Unit III: Animal Physiology, Veterinary Practices and Animal Conservation

15. Translations of Charaka Samhita -- P.V. Sharma -- Sanskrit Series
16. Translations of Sushruta Samhita -- Kaviraj Kunjalal Bhishagratna
17. Translations of Ashtanga Hridaya -- K.R. Srikantha Murthy -- Chaukhambha Sanskrit Series
18. Studies on Sacred Groves in India -- Ramachandra Guha, Madhav Gadgil, WWF.

Unit IV: Evolutionary Biology

19. Introduction of Evolution --- Moody
20. Evolution --- Savoge
21. Evolution --- Franklin Shull
22. Zoo Geography --- Darlington
23. A Text Book of Organic Evolution --- Mohan P. Arora & Himanshu Arora, Himalaya Publishing House
24. Organic Evolution --- N. Arumugam, Saras Publication
25. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology --- P. S. Verma & V. K. Agarwal

Course Level	5.5	Internal Marks	50
Programme	Zoology	External Marks	50
Semester	V	Practical Internal	--
Category of Course	Discipline Specific Major Courses (Major-12)	Practical External	--
Course Credit	04	Prac. External Exam Duration	--
Teaching Hours	60	Total	100
Course Code		Exam Duration	2.0 hrs
Course Title	Chordates-III and physiology		

Course Objectives: This course aims:

- To understand the evolutionary adaptations observed in chordates, highlighting key features in fish, amphibians, reptiles, aves, and mammals.
- To compare the anatomical structures of different vertebrate systems, including digestive, excretory, and nervous systems, across various classes.
- To learn the fundamental physiological processes of blood coagulation and respiration in vertebrates.
- To gain knowledge of the nervous and endocrine systems, including hormone action and the role of the lymphatic system.

Course Learning Outcomes: After completion of the course, students will be able to:

- Describe the unique evolutionary adaptations present in different chordate groups.
- Compare and contrast the anatomical features of vertebrate organ systems across different classes.
- Explain the physiological mechanisms of blood coagulation and respiration.
- Discuss the structure and function of the nervous, endocrine, and lymphatic systems in vertebrates.

Course Contents

Sem.	Unit No.	Syllabi	Teaching Hours
5	1	Evolutionary Adaptations in Chordata Fish: General organization and affinities of Dipnoi, Accessory Respiratory Organs in fishes, Air bladder in fishes, Types of Caudal fins. Amphibia: Neoteny, Reptile: Temporal fossae. Aves: Feathers; Synsacrum Mammals: Egg laying mammals, Dentition in mammals	15
	2	Comparative Anatomy of Vertebrates Digestive system: Embryonic digestive tract, Alimentary canal: Parts, Derivatives and Digestive glands Excretory System (Kidney): Structure, origin, Archinephrous, Pronephrous, Mesonephrous and Metanephrous kidneys Nervous System : Brain in Pisces, Amphibia, Reptilia, Aves and Mammals	15
	3	Physiology-I Physiology of blood coagulation, Diseases related to circulatory system: Atherosclerosis, Coronary Artery Disease, Congenital Defects, Arrhythmias, Heart Block Physiology of respiration : Pulmonary ventilation, Exchange of Gases, Transport of Gases, Control of Respiration, Respiratory pigments	15
	4	Physiology-II Nervous system: Types of nervous system, structure and types of neurons, conduction of nerve impulse. Endocrinology:- types of hormones, mechanism of hormones action: Parathyroid, Thymus, Testis, Ovary Lymphatic System: Lymphatic organs & tissues and its role	15

Suggested Readings:

1. Vertebrate Zoology -- R.L. Kotpal -- Rastogi Publications
2. Vertebrate Zoology -- E.L. Jordan, P.S. Verma -- S. Chand Publishing
3. Vertebrate Zoology -- Dr. S.N. Prasad -- Kitab Mahal
4. Chordate Structure and Function -- A.J. Waterman -- The Macmillan Company
5. Analysis of Vertebrate Structure -- Milton Hildebrand, David M. Wake, Patricia P. Wright -- John Wiley & Sons

6. An Outline of Comparative Anatomy -- J. Sterling Kingsley -- Henry Holt and Company
7. The Vertebrate Body -- Alfred Sherwood Romer, Thomas S. Parsons -- Saunders College Publishing
8. The Chordates -- R. McNeill Alexander -- Cambridge University Press
9. An Introduction to Comparative Zoology -- W.F.H. Barrett-Hamilton, Edward Wilson -- Adam and Charles Black
10. Vertebrates: Comparative Anatomy, Function, Evolution -- Kenneth Kardong -- McGraw-Hill
11. Chordate Zoology -- Robert K. Barnes, Edward E. Ruppert, Richard S. Fox -- Brooks Cole
12. Life: The Science of Biology -- David E. Sadava et al. -- W. H. Freeman and Company
13. Biology of the Vertebrates -- Stephen M. Norris, Kenneth Kardong, Kerry L. Mashburn -- McGraw-Hill
14. Principles of Anatomy and Physiology -- Gerard J. Tortora, Bryan H. Derrickson -- Wiley
15. Human Physiology -- Dee Unglaub Silverthorn -- Pearson
16. Medical Physiology -- Walter F. Boron, Emile L. Boulpaep -- Saunders/Elsevier
17. Guyton and Hall Textbook of Medical Physiology -- John E. Hall, Arthur C. Guyton - - Saunders/Elsevier
18. Animal Physiology -- Knut Schmidt-Nielsen -- Cambridge University Press

Course Level	5.5	Internal Marks	50
Programme	Zoology	External Marks	--
Semester	V	Practical Internal	--
Category of Course	Discipline Specific Major Courses (Major-13)	Practical External	50
Course Credit	04	Prac. External Exam Duration	4 hrs
Teaching Hours	120	Total	100
Course Code		Exam Duration	4 hrs
Course Title	Zoology in Indian Knowledge Systems, evolutionary biology, Chordates-III and physiology		

Course Objectives: This course aims:

- To understand the evolutionary adaptations observed in chordates, highlighting key features in fish, amphibians, reptiles, aves, and mammals.
- To compare the anatomical structures of different vertebrate systems, including digestive, excretory, and nervous systems, across various classes.
- To learn the fundamental physiological processes of blood coagulation and respiration in vertebrates.
- To gain knowledge of the nervous and endocrine systems, including hormone action and the role of the lymphatic system.

Course Learning Outcomes: After completion of the course, students will be able to:

- Describe the unique evolutionary adaptations present in different chordate groups.
- Compare and contrast the anatomical features of vertebrate organ systems across different classes.
- Explain the physiological mechanisms of blood coagulation and respiration.
- Discuss the structure and function of the nervous, endocrine, and lymphatic systems in vertebrates.

Course Contents

Sem.	Practical no.	Syllabi	Teaching Hours
5	1.	To document the plant and animal diversity in a local sacred grove and understand its cultural importance.	60
	2.	To record and describe the unique characteristics of indigenous Indian cattle breeds.	
	3.	To record and describe the unique characteristics of indigenous Indian horse breeds.	
	4.	To analyze local folksongs, traditional stories and festivals to identify ecological insights related to animals.	
	5.	To survey and document the local plant species traditionally utilized for animal care.	
	6.	Study of different zoogeographical realms with the help of world map.	
	7.	Study of animals of oriental region (Cat fish (<i>Wallago attu</i>), <i>Rhacophorus</i> , Himalayan Newt, Oriental Garden Lizard (<i>Calotes</i>), King Cobra (<i>Ophiophagus</i>), Roofed Terrapin, Indian Peafowl (<i>Pavo cristatus</i>), Hare (<i>Lepus</i>), Squirrel (<i>Funambulus</i>), and Indian Hedgehog).	
	8.	To study macroevolution through specimen/chart.	
	9.	To study microevolution through specimen/chart.	
	10.	To study types of speciation.	
	11.	To identify and describe unique morphological features of lungfishes through specimen/chart.	60
	12.	To study different types of caudal fins in fishes.	
	13.	To understand neoteny in amphibians through preserved specimens/charts (e.g., Axolotl, Necturus, and Sirens).	
	14.	To examine different types of temporal fossae in reptilian skulls.	
	15.	To study types of feathers in Birds.	
	16.	To study dentition in mammals. (Pig, Horse, Dog, Bat, Goat).	
	17.	To study comparative anatomy of vertebrate digestive system through charts/model.	
	18.	To study comparative anatomy of vertebrate kidney through charts/model.	
	19.	To study comparative anatomy of vertebrate brain through charts/model.	
	20.	To estimate the haemoglobin content.	
	21.	To determine the total red blood cell (RBC) count.	

22.	To determine the total white blood cell (WBC) count.	
23.	To examine the histological structure of parathyroid, testis and ovary by permanent slides.	
24.	To examine the histological structure of lymph nodes, spleen, and thymus by permanent slides.	

Suggested Readings:

1. India: A Sacred Geography of the Goddess--David Kinsley--Indica Books
2. Folk Culture and Environment--Edited by Vandana Shiva, Radha Holla Bhar--Rawat Publications
3. Traditional Knowledge Systems of India--Edited by Biswajit Dhar, P.P. Dhyani, V.P. Tewari--Concept Publishing Company
4. Vanishing Herds: The Tragedy of India's Commons--Pratap Aggarwal--Tara Books (Relevant for animal husbandry and indigenous breeds)
5. Indigenous Cattle of India--P.N. Bhat--Indian Council of Agricultural Research (ICAR)
6. Horses of India--S.P. Sharma--Pragati Publications
7. A text book of practical zoology-Vertebrate --S.S. Lal
8. Biology of Reptiles--Carl Gans--Academic Press
9. Functional Anatomy of the Vertebrates: An Evolutionary and Biomechanical Perspective--Karel F. Liem, Warren F. Walker Jr., Lori Ann Witmer--Brooks Cole
10. Ornithology--Frank B. Gill--W. H. Freeman and Company
11. Mammalogy: Adaptation, Diversity, Ecology--George A. Feldhamer, Lee C. Drickamer, Stephen H. Vessey, Joseph F. Merritt, Carey Krajewski--Johns Hopkins University Press
12. Comparative Anatomy of the Vertebrates--Kent, George C., Carr, Robert K.--McGraw-Hill
13. Guyton and Hall Textbook of Medical Physiology--John E. Hall--Elsevier
14. Ross Histology: A Text and Atlas--Wojciech Pawlina, Michael H. Ross--Lippincott Williams & Wilkins

Course Level	5.5	Internal Marks	50
Programme	Zoology	External Marks	50
Semester	5	Practical Internal	--
Category of Course	Discipline Specific Minor Courses (Minor-4)	Practical External	--
Course Credit	04	Prac. External Exam Duration	--
Teaching Hours	60	Total	100
Course Code		Exam Duration	2 Hrs.
Course Title	Environmental science, wildlife population sampling and biostatistics		

Course Objectives: This course aims to:

- Provide students with a comprehensive understanding of Earth's natural resources, environmental pollution, and sustainable solutions.
- Students will learn about various pollutants, their sources, impacts, and mitigation strategies, as well as the importance of sustainable resource management. It will also address the relationship between human activities, environmental degradation, and global issues like global warming.
- Students will gain basic theoretical knowledge on different methods to capture/sample various invertebrate and vertebrate taxa
- Equip students with gaining detailed understanding of the basic statistical concepts and various steps involved in assessing and analysing data on hand.

Course Learning Outcomes: After completion of the course, student will be able to:

- Assess and analyse environmental problems, develop solutions, and understand the ecological and societal value of natural resources, sustainable solutions and environmental stewardship.
- Get a comprehensive understanding and hands-on training of various field methods used for diverse invertebrate and vertebrate faunal assemblages.
- Learn basics of various steps involved in organizing, analysing and interpreting field or lab data using simple biostatistical tools and techniques.

Course Contents

Sem.	Unit No.	Syllabi	Teaching Hours
5	1	Natural Resources 1.1 Introduction to Earth's resources. 1.2 Renewable natural resources. 1.3 Non-renewable resources. 1.4 Role of an individual in conservation of natural resources.	10
	2	Environmental Pollution 2.1 Definition, Types, classification of pollution and its effects on humans: Air pollution; Water pollution; Soil pollution. 2.2 Major anthropogenic global environmental problems and case studies: (a) Acid rain, (b) Green-house effect, (c) Ozone depletion, (d) Global Warming. 2.3 Role of an individual in prevention of pollution.	11
	3	Wildlife population sampling techniques 3.1 Invertebrate Sampling Techniques: Flight interception traps for flying insects, Light traps for nocturnal insects, Sugaring for moths, Pitfall traps, Beating, Sweep netting, Suction sampling, Bait traps. 3.2 Vertebrate Sampling Techniques (A) Amphibia: Toe clipping, Drift fencing, Trapping. (B) Reptiles: Hand capturing, Noosing, Trapping, Marking. (C) Birds: nest counts, roost counts, lek count, migrant count, point count, transect surveys, flock count, catch per unit effort, response to playback. (D) Mammals: herd/group counts, trapping and capture methods, point count, line transects, catch per unit effort, Indirect evidence, and sign survey.	12
	4	Biostatistics 4.1 Basic statistical concepts and terminology 4.2 Data types: (a) primary (b) secondary, and Data sources: (a) Experiments (b) surveys (c) records and literature 4.3 Types of data variables: (a) Quantitative (b) Qualitative 4.4 Classification of data; Types and methods of data classification and tabulation 4.5 Data visualization using common graphical methods: (a) scatter plots (b) time series plots (c) bar chart (d) histogram (e) box plot. 4.6 Descriptive statistics: (a) measures of Central tendency: mean, median, mode (b) measures of variability: range, variance and standard deviation, coefficient of variation	12

Suggested Reading:

1. Fundamentals of Ecology --- P. S. Odum, Saunders
2. Concepts of Ecology --- N. Arumugam, Saras Publication, Nagercoil
3. Ecology --- Ricklefs, W. H. Freeman
4. Elements of Ecology --- Sharma & Mishra
5. Ecology The Experimental Analysis Of Distribution And Abundance- Charles J. Krebs
6. Exploratory Data Analysis-- John W. Tukey
7. Practical Statistics for Data Scientists --- Peter Bruce & Andrew Bruce
8. Basics Biostatistics – Biswanath Patra et al
9. Biostatistical Analysis – Jerrold Zar
10. Introduction to Statistical Methods, Design of Experiments and Statistical Quality Control -- Selvamuthu Dharmaraja, Dipayan Das, Springer.
11. An Introduction to Probability and Statistics -- Vijay K. Rohatgi and A.K. Md. Ehsanes Saleh, John Wiley, second edition.

Course Level	5.5	Internal Marks	50
Programme	Zoology	External Marks	--
Semester	V	Practical Internal	--
Category of Course	Discipline Specific Minor Courses (Minor-5)	Practical External	50
Course Credit	04	Prac. External Exam Duration	04 hrs
Teaching Hours	120	Total	100
Course Code		Exam Duration	04 hrs
Course Title	Practical: Environmental science, wildlife population sampling and biostatistics		

Course Objectives: This course aims to:

- Students will get basic practical training in techniques and tools used for studying invertebrate populations.
- Student will get hands on practice of different sampling and census methods, capture techniques and equipment used for amphibia, reptiles, birds and mammals.
- Equip students with gaining detailed practical training of the stepwise basic statistical analysis using simple statistical tools.

Course Learning Outcomes: After completion of the course, student will be able to:

- Get a comprehensive understanding and hands-on training of various field methods used for diverse invertebrate and vertebrate faunal assemblages.
- Learn practical aspects involved in organizing, analysing and interpreting field or lab data using simple biostatistical tools and techniques.

Course Contents

List of Practical

No.	Syllabi	Teaching hours
Practical 1	Invertebrate population sampling-I: (a) Beating (b) Sweep Netting (c) Suction sampling	120
Practical 2	Invertebrate population sampling-II: (a) Flight interception traps (b) Light traps (c) Aerial attractant traps	
Practical 3	Invertebrate population sampling-III: (a) Sugaring (b) Emergence traps (c) Pitfall traps	

Practical 4	Vertebrate population sampling techniques-I : (a) Trapping amphibians and reptiles (b) Noosing limbed reptiles (c) Drift fencing for amphibians	
Practical 5	Vertebrate population sampling techniques-II: recognizing/markings individuals in amphibians, reptiles and mammals	
Practical 6	Vertebrate population sampling techniques-III: (a) Counting nests in a heronry (b) Counting leks of peafowl	
Practical 7	Vertebrate population sampling techniques-IV: Counting roosts of black kites and Indian flying fox	
Practical 8	Vertebrate population sampling techniques-V: Bird population sampling using point count	
Practical 9	Vertebrate population sampling techniques-VI: Belt transect for butterflies	
Practical 10	Use appropriate graphical method to visualize the provided dataset	
Practical 11	Calculate the central tendency for the given dataset (Mean, Median and mode)	
Practical 12	Calculate the measures of dispersion for the given dataset (Range, Variance, Standard deviation and Coefficient of variation)	
Practical 13	Field work report	

Suggested Readings:

1. Textbook for Environmental studies --- Erach Bharucha, UGC, New Delhi
2. Fundamentals of Ecology --- P. S. Odum, Saunders
3. Concepts of Ecology --- N. Arumugam, Saras Publication, Nagercoil
4. Elements of Ecology ---Sharma & Mishra
5. Ecological census techniques- W. J. Sutherland
6. Exploratory Data Analysis-- John W. Tukey
7. Basics Biostatistics – Biswanath Patra et al
8. Biostatistical Analysis – Jerrold Zar
9. Biostatistics: P. Ramakrishnan by Saras Publication

Theory Examination Paper Style NEP 2020**SEMESTER – V****Major- 11,12/Minor-4 (Theory)****Time: 2 Hours****Total Marks: 50****Instructions:**

1. Illustrate your answer with neat and labelled diagrams.
2. Figure to the right side indicates full marks of questions.

EXTERNAL ASSESSMENT BY UNIVERSITY			
Que. No.	Particulars	Unit	Marks
Que. 1	(1)	Unit 1	05
	(2)		05
	Or		
	(1)		05
	(2)		05
Que. 2	(1)	Unit 2	05
	(2)		05
	Or		
	(1)		05
	(2)		05
Que. 3	(1)	Unit 3	05
	(2)		05
	Or		
	(1)		05
	(2)		05
Que. 4	(1)	Unit 4	05
	(2)		05
	Or		
	(1)		05
	(2)		05
Que. 5	(1)	Unit 1 & 2	05
	(2)		05
	Or	Unit 3 & 4	
	(1)		05
	(2)		05
Total			50

Practical Examination Paper Style NEP 2020**Major-13 : Zoology in Indian Knowledge Systems, Evolutionary Biology, Chordates-III and physiology****Time: 4 Hours****Total Marks: 50**

Part-A (Practical 1-10)		
Que. No.	Particulars	Marks
Que-1	Write a folksong/story for ecological insights related to animals. (Practical-4)	03
Que-2	Do as per instruction and show it to examiner. (Practical-6)	03
Que-3	Identify and describe distribution of the species. (Practical-7)	02
Que-4	Identify and describe distribution of the species. (Practical-7)	02
Que-5	Write as per instruction. A. Identify and Describe (Practical-2) B. Identify and Describe (Practical-3) C. Identify and Describe (Practical-8) D. Identify and Describe (Practical-9) E. Identify and Describe (Practical-10)	10
Que-6	Certified Journal.	02
Que-7	Viva-voice.	03
Part-B (Practical 11-24)		
Que. No.	Particulars	Marks
Que-1	Do as per instruction and show it to examiner. (RBC/WBC/Haemoglobin content). (Practical-20/21/22/)	06
Que-2	Describe dentition formula of the provided mammal's skull/chart. (Practical-16)	03
Que-3	Identify and describe comparative anatomy of vertebrates. (Practical-17/18/19)	03
Que-4	Write as per instruction. A. Identify and Describe (Practical-11/12) B. Identify and Describe (Practical-13/15) C. Identify and Describe (Practical-14) D. Identify and Describe (Practical-23/24)	08
Que-5	Certified Journal.	02
Que-6	Viva-voice.	03

Practical Examination Paper Style NEP 2020

**Minor-05 : Practical: Environmental science, wildlife population sampling and
biostatistics**

Time: 4 Hours

Total Marks: 50

Que. No.	Particulars	Marks
Que-1	Do as per instructions and show it to examiner. (Practical-1/2)	04
Que-2	Do as per instructions and show it to examiner. (Practical-3)	04
Que-3	Do as per instructions and show it to examiner. (Practical-4)	04
Que-4	Do as per instructions and show it to examiner. (Practical-5)	04
Que-5	Do as per instructions and show it to examiner. (Practical-6/7)	04
Que-6	Do as per instructions and show it to examiner. (Practical-8/9)	04
Que-7	Use appropriate graphical method to visualize the provided dataset. (Practical-10)	05
Que-8	Calculate the central tendency for the given dataset. (Practical-11)	05
Que-9	Calculate the measures of dispersion for the given dataset. (Practical-12)	05
Que-10	Field work report	04
Que-11	Certified Journal.	03
Que-12	Viva-voice.	04