University of Pune

M. Sc. Biodiversity – Monitoring and Utilization

Credit & Semester System Syllabus

Degree: Master of Science (M. Sc.) Part I

Subject: Biodiversity

Faculty: Science
A.Y. : – 2014-15

General Information

M. Sc. Biodiversity - Monitoring and Utilization (Credit & Semester System) is a two year postgraduate course, comprising four semesters and is a unique program conducted at Abasaheb Garware College, Pune; since 2003. The course was sanctioned under Innovative Programs Scheme of University Grants Commission. The curriculum gives holistic coverage to the extremely valuable field of Biodiversity. Biodiversity is the largest source of potential wealth for the country, which remains grossly under explored. One of the reasons for the under utilization is the dearth of trained manpower. The current generation of biologists is largely divided into field-oriented taxonomists and ecologists on the one hand and the lab oriented functional and molecular biologists on the other. This divide has become a limiting factor in the study of Biodiversity. The present program intends to bridge the gap by inculcating excellence in field and laboratory biology simultaneously. This capacity building exercise will help generating wealth through a prudent and sustainable use of the country's bioresources.

The course consists of four semesters;

- The first year comprising two semesters is extensively field oriented and the second year is lab intensive.
- The first semester is devoted to taxonomy and diversity of various life forms and emphasizes on basic techniques of exploration of diversity.
- Second semester focuses on natural history and is supplemented adequately with quantitative techniques in biology and ecology. Human ecology component which forms the key component in shaping up of natural systems has also been included here.
- First and second semesters together emphasize on conceptual as well as empirical knowledge of the ways in which natural systems work.
- The first two semesters can make a good naturalist and ecologist.
- Third and fourth semester will expose students to various facets of environment, conservation and utilization of bioresources.
- Students will undertake a dissertation in the second year and depending upon the nature of their planned work, they will have an option of doing it in either 3rd or 4th semester.

Centre where the course is offered : Dept. of Biodiversity, MES Abasaheb Garware College, Pune – 411004.

Eligibility Criteria:

    a. Bachelor in - Science (any branch) / Engineering (any branch) / Agriculture / Fisheries / Pharmacy / Forestry / Medicine with minimum 50% of marks

    b. Clearing the entrance examination

Admission: The candidate should appear for the entrance test. The merit list will be based only on marks obtained in entrance test. Marks of qualifying graduate examination will be considered for tie-breaking.

Fee Structure: As per University of Pune guidelines for self supported post graduate courses in colleges.

Course structure: There shall be four semesters, at each semester there will be 3 theory courses and 2 practical courses. In the first semester, there shall be only core/compulsory credits (TC). Second semester shall consist of 2 core/ compulsory and 1 non-core/optional credit (TNC). In the third semester, there shall be 1 core/ compulsory credits and 2 non-core/optional credit. In fourth semester, there will be 1 core/ compulsory credit and 2 non-core/optional credit, for theory. Each practical course shall have 5 core / compulsory credits (PC).

Following is the outline of the course structure.

Semester	Theory (60 credits)		Practical (40 credits)
	Core /Compulsory (credits)	Non-core /Optional (credits)	Core / Compulsory (credits)
I	15	0	10
II	10	5	10
III	5	10	10
IV	5	10	10

Detail course structure of M.Sc. – Part I

Semester	Paper code	Name of the Subject	Credits	
Semester I	BD - TC 101	Plant Taxonomy, Diversity and Economic Botany	5	Core
	BD - TC 102	Animal Taxonomy and Diversity	5	Core
	BD - TC 103	Microbial Taxonomy, Diversity and Ecology	5	Core
	BD - PC 111 Practical	Taxonomy: Field Methods	5	Core
	BD - PC 112 Practical	Taxonomy: Lab Methods	5	Core
Semester II	BD – TC 201	Ecology and Evolutionary Biology	5	Core
	BD – TC 202	Quantitative Biology	5	Core
	BD – TNC 203	Biogeography and Human Ecology	5	Non Core
	BD – TNC 204	Pollution and Climate Change	5	Non Core
	BD – PC 211 Practical	Field Ecology Techniques	5	Core
	BD – PC 212 Practical	Quantitative Techniques in Ecology	5	Core
	Total Credits		**50**	

Medium of instruction – English

Workload: There shall be 15 teaching hours per credit (1 hour / credit / week), out of which classroom contact hours will be 12 and 3 hours for preparation of in-semester continuous assessment comprising of seminars, mini projects, assignments, library notes, extension works and short quizzes. Each laboratory course will occupy six hours / week / batch.

Equivalence :- Syllabus is designed as per Credit system so there is no equivalence between Old and New Syllabus.

Semester I

Paper code and Title	Credit Title
BD – TC 101: Plant Taxonomy, Diversity and Economic Botany	Introduction and theory of Plant Taxonomy
	Study of plant groups
	Study of important families of Angiosperms
	Plant diversity application
	Biosystematics, diversity studies and human well being
BD – TC 102: Animal Diversity and Taxonomy	Introduction to animal diversity and taxonomy
	Animal study techniques
	Classification of Animal kingdom I
	Classification of Animal kingdom II
	Diversity documentation and dissemination
BD – TC 103: Microbial Taxonomy, Diversity and Ecology	Microbial diversity
	Culturing microorganisms
	Bacterial diversity
	Chemical and biochemical methods of analysis
	Fungi
BD – PC 111: Practical Course: Taxonomy - Field Methods	Study of external morphology of major plant groups, primarily angiosperms
	Use of taxonomic literature
	Field visits (various habitats – Dry region, Moist/dry deciduous forest, Lateritic plateau etc)
	Diversity and morphology of Animal taxa
	Methods of collection
BD - PC 112: Practical Course: Taxonomy - Lab Methods	Cultivation, isolation & maintenance of microorganisms (Bacteria & Fungi) I
	Cultivation, isolation & maintenance of microorganisms (Bacteria & Fungi) II
	Cultivation, isolation & maintenance of microorganisms (Bacteria & Fungi) III
	Protozoan diversity
	Species database & Culture collection visit

Semester II

Paper code and Title	Credit Title
BD – TC 201: Ecology and Evolutionary Biology	Population growth and Population interactions
	Community ecology
	History and development of evolutionary theory
	Neutral evolution and molecular clocks
	Factors governing biodiversity
BD - TC 202: Quantitative Biology	Descriptive statistics and measures of dispersion
	Probability distribution and Hypothesis testing
	Comparison of means, Correlation, Regression
	Experimental Design, Factorial Experiments
	Multivariate analysis
BD – TNC 203: Biogeography and Human Ecology	Biogeography
	Patterns and types of distributions
	Speciation, Island Biogeography
	Human Ecology I
	Human Ecology II
BD – TNC 204 : Environmental Pollution and Climate Change	Introduction to environment, biotic and abiotic factors
	Soil Pollution – Causes, Effects and Remedies
	Water Pollution – Causes, Effects and Remedies
	Air Pollution – Causes, Effects and Remedies
	Climate change
BD – PC 211: Practical Course: Field Ecology Techniques	Sampling Strategies – Plant taxa
	Species area curve, girth class distribution
	Importance Value Index, Family Importance Value, Biomass estimation
	Sampling strategies - Animal taxa
	Use of Maps and Survey of India (SOI) Toposheets
BD – PC 212: Practical Course: Quantitative Techniques in Ecology	Introduction to computers, Excel, Univariate analysis
	Diversity Indices, similarity and dissimilarity indices
	Statistical packages and clustering
	Simulation models of growth and population interactions
	Methods of estimating population densities and population growth rates

Examination: Assessment shall consist of an in-semester continuous assessment and end of semester assessment as per the University rules. Since Abasaheb Garware College is the only centre running this course, setting of exam papers and CAP will be done in the college as per University rules.

Guidelines for Internal and Project Assessment : The internal assessment is carried out for all the subjects. The assessment is based on seminars, paper presentations, debates and written examinations. Biodiversity course being field intensive, visits to forested landscapes forms an integral part of the overall practical component. Practical examination will combine both field and lab exercises that test the knowledge and understanding of the subject.

Standard of Passing : The award of grades, ATKT and marks for passing, etc. will be as per the University of Pune rules.

SEMESTER I

BD – TC 101: Plant Taxonomy, Diversity and Economic Botany

A) i) Introduction: Concept of species, variation   (1 Credit)
   ii) Theory of plant taxonomy:
      a. Introduction to major plant groups
      b. Evolutionary relationships between plant groups
          - Englerian & Rannalian School of thought
          - Bennettitalean, Gnetalian, Pteridosperms & Caytonialean ancestry
      b. Nomenclature and History of plant taxonomy
          - ICBN,
          - Typification concept, Principle of Priority
          - Valid & scientific names, Rules regarding coining & rejection of names
          - Brief history of plant taxonomy
      c. Systems of classification and their application
          - Overview of Natural, Artificial & Phylogenetic systems
          - Linnaeus, Bentham & Hooker, Engler & Prantl, Hutchinson, APG systems

B) Study of plant groups :   (1 Credit)
      a. Morphology and anatomy of major plant groups
          - Bryophytes (General classification, Case study, Alteration of generations)
          - Pteridophytes (General & special features, Case study, Significance of
            heterospry, Alteration of generations)
          - Gymnosperms (General features, Case study, Similarities with Angiosperms,
            Alteration of generations)
          - Angiosperms
      b. Study of identification characters
          - Qulitative, quantitative, synthetic & analytical characters
          - Vegetative characters (Leaf type, arrangement, shapes)
          - Sexual characters (Floral morphology, study of fruits)

C) Study of important families of Angiosperms   (1 Credit)
          - Primitive & advanced families including Nymphaeaceae, Annonaceae,
            Magnoliaceae, Anacardiaceae, Leguminosae, Rubiaceae, Cucurbitaceae,
            Asclepiadaceae, Asteraceae, Acanthaceae, Lamiaceae, Casuarinaceae,
            Euphorbiaceae, Liliaceae, Scitaminae, Orchidaceae, Poaceae

D) Plant diversity application

  (i) Economic Botany   (1 Credit)
- a. Medicinal plants (Plants commonly used in traditional, modern medicine with their uses)
- b. Spices & Condiments (Cinnamon, Clove, Pepper)
- c. Beverages (Tea, Coffee, Cocoa)
- d. Timber (Teak, Sal)

  (ii) Documentation and dissemination:
- a. Collection and preservation techniques
- b. Recording information in field and laboratory
- c. Photography, Illustration
- d. Referencing and citation
- e. Preparation of keys, reports

E) Biosystematics, its application for diversity studies and human well being   (1 Credit)
- a. Biosystematics with use of ecology, population biology, chemistry, palynology, molecular biology and numerical taxonomy
- b. Use of reference material (Floras, keys), herbaria and databases for plant identification
- c. Non Timber Forest Produce – NTFP (Wild edible plants, minor forest produce) as a source of human well being

In semester evaluation - Short quizzes, mid-term tests, seminars related to Plant diversity and Economic Botany

Suggested Readings :-

1. Naik, V. N. (1984). *Taxonomy of Angiosperms.* Tata McGraw-Hill Education.

2. Heywood,V., Burmitt, R., Culham, A. and Seberg, O. (2007). *Flowering plant families of the world.* Kew Books (Europe) Firefly Books (North America).

3. Pandey, B. P. (2001). *A textbook of Botany:Angiosperms- Taxonomy, Anatomy, Economic Botany & Embryology.* S. Chand, Limited.

4. Cooke, T.C. (1958a reprint edition) *Flora of the Presidency of Bombay Presidency—Vol. 1 to 3.* Botanical Survey of India, Kolkata

5. Singh N.P & S. Karthikeyan (eds.) (2000). *Flora of Maharashtra—Vol. I and II Series 2.* Botanical Survey of India, Kolkata

6. Talbot, W.A. (1911). *Forest Flora of the Bombay Presidency and Sind . Vol. 2* (Poona : Government Photozicographic Press).

7. Jain, D.K. and Singh, V. (2012)*. Taxonomy of Angiosperms. 8th Ed.* Rastogi Publications.

8. Maiti, R. K. and Singh, V. P. (2009). *An introduction to Modern Economic Botany*. Agrobios.

9. Kochhar, S. L. (2012). *Economic Botany In the Tropics, 4/e.* Macmillan Publishers India.

10. Nehra, S. (2007). *Economic Botany.* Pointer Publishers.

11. Hill, A. F. (). *Economic Botany: A Textbook of Useful Plants and Plant Products 2nd edition*. McGraw-Hill.

12. Simpson, B. and Ogorzaly, M. (2001). *Economic Botany: Plants in our world*. McGraw-Hill.

BD - TC 102: Animal Diversity and Taxonomy

A) Introduction to Animal Diversity and Taxonomy   (1 Credit)
   a. Principles and rules of Taxonomy, ICZN Rules
   b. Concepts of taxon, categories, holotype, paratype, topotype etc.
   c. Ethical and Humane treatment to animals, DOs and DON'Ts.
   d. Preservation of animal specimens for taxonomic purposes.
   e. Field data collection for taxonomic studies.

B) Animal Study Techniques   (1 Credit)
   a. Methods of Field data collection for taxonomic studies
   b. Use of techniques like net sweeping, pit fall traps, light traps, Berlese funnel, smoking, aspirators, mark-recapture
   c. Use of Taxonomic literature and study of key characters for identification of the specimen.

C) Classification of Animal kingdom I   (1 Credit)
   a. Brief classification of animals
   b. Study of invertebrates upto class level for
        Echinoderms, Annelids, Molluscs, Arthropods (study in detail about Crustacea, Arachnida, Chilopoda, Diplopoda, Hexapoda)

D) Classification of Animal kingdom II   (1 Credit)
   a. Study of vertebrate orders
        Amphibians, Reptiles, Birds, Fish, Mammals
   b. Minor phyla and their importance in phylogeny, connecting links.

E) Documentation and dissemination   (1 Credit)
   a. Collection and preservation techniques
   b. Noting key characters for information recording on field
   c. Photodocumentation of diagnostic features
   d. Description of species
   e. Referencing and citation
   f. Preparation of keys, reports

In semester evaluation - Case studies, seminar, group discussions, related to environmental component pertaining to Wildlife, Animal Behaviour

Suggested Readings :-

1. Smith, M. A. (1943). *The fauna of British India, Ceylon and Burma including the whole Indo-chinese Sub- region Reptilia and Amphibia.3(Serpentes)* London: Taylor and Francis.

2. Alcock, J. (2009) Animal Behavior: An Evolutionary Approach (9th edition). Sinauer Associates, Sunderland, MA.

3. Ali, S.and Ripley,S. (1999). *Handbook of birds of India and Pakistan Edn.2* Oxford University Press.

4. Daccordi, Triberti and Zanetti (1988). *The MacDonald Encyclopedia of Butterflies And Moths*. Macdonald, London.

5. Ali, S. and Ripley, S.D. (1983). *A pictorial Guide to the Birds of the Indian Subcontinent.* Bombay Natural History Society and Oxford University Press.

6. Prater, S.H. (1971). *The book of Indian animals. 3rd Edn,* Bombay Natural History Society and Oxford University Press.

7. Preston-Mafham and Preston-Mafham. (2003). *Primates of the World.* Facts On File Inc.

8. Kotpal, R.L. (2005). *Arthropoda. 11th Edn.* Rastogi Publications.

9. Kotpal, R.L. (2012). *Modern Text Book of Zoology, Invertebrates, 10th Edn.* Rastogi Publications.

10. Preston-Mafham. (1993). *The Encyclopaedia of Land Invertebrate Behaviour.* London: Blandford Press.

11. Ashlock, P.D. (1991). Principles of Systematic Zoology, 2nd Edn. Mcgraw-Hill College.

BD – TC 103: Microbial Taxonomy, Diversity and Ecology

A) Microbial Diversity   (1 Credit)
         a**.** Microbes and Earth History
         b. Magnitude, occurrence and distribution.
         c. Concept of species, Criteria for classification, Outline classification microorganisms
         (Bacteria, Viruses and Protozoa)
         d. Overview of methods in taxonomy of bacteria

B) Culturing microorganisms   (1 Credit)
         a. Cultivation and isolation of microorganisms – Aerobic and Anaerobic methods
         b. Nutritional requirements, Growth media and cultivation, Pure culture isolation, enrichment, maintainance and culture collection.
         c. Micro-organisms in extreme environments
         d. Newer approaches for exploring unculturable bacteria.

C) Bacteria   (1 Credit)
         a.Morphology in Actinomycetes, Cyanobacteria ,Myxobacteria, Mycoplasma, Spirochetes
         b.Biochemical characterization- Gram Character, Enteric bacteria, Aerobic and Anaerobic bacteria,
         c.Serotyping, Phage typing.
         d.Major classes of bacteria of ecological, agricultural and environmental importance.

D) Chemical and biochemical methods of analysis: (1 Credit)
         a. Cell wall composition, analysis
         b. Lipids and fatty acid profile analysis
         c. Protein profiles and isozymes analysis

E) Fungi: (1 Credit)
         Criteria for classification and identification -
         Types of vegetative forms, Types of spores, fruiting bodies, life cycles.
         a. Outline classification of fungal kingdom
         b.Taxonomic keys, Identification keys

In semester evaluation - Assignments, library notes, presentations related to microbial ecological interactions: Bioremediation, Biocontrol

Suggested Readings :-

1. Breed et. al. (1952). *Bergey's Manual of Determinative Bacteriology. 7th Edition,* The Williams & Wilkins Company, Baltimore.

2. Breed and Buchanan. (1982). *Bergey's Manual of Determinative Bacteriology. 9th Edition,* The Williams & Wilkins Company, Baltimore.

4. Watve, M.G and Paknikar, S.K. (1996). *Microbiology: A practical approach, Manali Prakashan-Pune*

5. Prescott, L.M., Harley, J.P., and Klein D.A. (2005). *Microbiology, 6th Edn.* MacGraw Hill Companies Inc.

6. Pelczar, M. J, Jr. and Chan, E.C.S. (1981). *Elements of microbiology.* Tokyo: Kogakusha-McGraw Hill.

7. Stanier, R.Y., Adelberg, E.A. and Ingraham, J.L. (1987) *General Microbiology, 5th Edn.* Macmillan Press Ltd.

8. Tortora, G.J., Funke, B.R. and Case, C.L. (2006). *Microbiology: An Introduction. 8th Edn.* Pearson Education Inc.

9. Mukerji, K. G. and Manoharachary, C. (2010). *Taxonomy And Ecology Of Indian Fungi,* I. K. International Pvt Ltd.

10. Nelson, D. L. and Cox, M. M. (2002). *Lehninger's Principles of Biochemistry,* Mac Millan Worth Pub. Co. New Delhi.

11. J. T. Bonner., *Researches on cellular slime moulds: selected papers*

12. Zimmer, C. (2011). *The planet of Viruses.* University Chicago Press.

BD – PC 111: Taxonomy - Field Methods

(1 Credit)

a. Study of external morphology of major plant groups, primarily angiosperms
 - Leaf morphology, habit variation
 - Floral morphology and variation
 - Types of aestivation & placentation
 - Study of fruits

(1 Credit)

b. Identification and description using taxonomic literature
 - Visits to herbaria, gardens, culture collections (BSI, ZSI)
 - Preparation of dichotomous keys

(1 Credit)

c. Survey of local market for studying vegetable diversity
 - Visit to lateritic plateaus, grasslands, forests to understand plant diversity
 - Collection and preservation of different plant groups primarily angiosperms

(1 Credit)

d. Collection & morphology of Insects
 - Field visit to study diversity of Arachnids
 - Visit to local fish market for identification, morphometry
 - Study of Amphibians, Reptiles by visit to forest areas

(1 Credit)
e. Methods of dry and wet preservation of animals
 - Study of traps
 - Pitfall, light, pan traps
 - Photography and illustration in field and laboratory conditions

BD - PC 112: Taxonomy - Lab Methods

(1Credit)

a. Cultivation, isolation & maintenance of microorganisms (Bacteria & Fungi) I

- Introduction to Tools, Instruments and equipments used in Basic Microbiological work.
- Nutritional requirements
- Growth media

(1 Credit)

b. Cultivation, isolation & maintenance of microorganisms (Bacteria & Fungi) II

- Pure culture isolation
- Observing bacteria (Staining techniques – monochrome, differential, negative, Motility)

(1 Credit)

c. Cultivation, isolation & maintenance of microorganisms (Bacteria & Fungi) III

-Enrichment media for (Different groups of microorganisms – Acid producers, Antibiotic producers, Actinomycetes, environmentally important fungi and bacteria, cyanobacteria etc.)

(1 Credit)

d. Methods of cultivation and identification of Protozoans and microscopic crustaceans.

(1 Credit)

e. Species databases and Molecular methods of taxonomy, numerical taxonomy
   Visit to culture collection centers

SEMESTER II

BD – TC 201: Ecology and Evolutionary Biology

A) Population growth and Population interactions: (1 Credit)
    a. Growth types and growth models, exponential, logistic and chemostat models and their variants, populations with age structure, age class distributions, Effect of environment on population growth. stochasticity in growth
    b. Growth efficiency and growth yield: Laws of thermodynamics, energetics of growth, biomass conversion rates. r and K selection strategies.
    c. Types of interactions, models of competition, predator-prey dynamics. Empirical and experimental studies on population interactions

B) Community ecology: (1 Credit)
Definition of population and community, characteristics of community, composition of community, structure/ stratification of community,
    a. ecological succession
    b. habitat, niche and guild
    c. relationship between ecosystem stability and diversity
    d. floristic regions of the world with emphasis in India

C) History and development of evolutionary theory (1 Credit)
    a. Neodarwinism: spontaneous mutation controversy, effects of natural selection on populations, stabilizing and dispersing selections, Levels of selection, group selection controversy, selfish gene theory.
    b. Kin selection and sociobiology, evolution of cooperation, sociality, game theory.

D) Neutral evolution and molecular clocks (1 Credit)
    a. Molecular diversity, phylogeny and molecular distances,
    b. Reconstructing evolutionary origins from molecular studies.
    c. Evolution and stability of sex, sexual selection, evolution of secondary sexual characters

E) Factors governing biodiversity (1 Credit)
 a. Biodiversity hot-spots, diversity distribution, factors affecting diversity,
 b. Impact of exotic species, disturbance on diversity, dispersal, diversity-stability relationship

In semester evaluation – Paper presentations, Assignments related to ecosystem interactions

Suggested Readings :-

1. Jha, A. P. (1993). *Genes and Evolution.* Darbhanga: Macmillan India.

2. Dennett, D.C. (1995). *Darwin's dangerous idea, Evolution and Meaning of Life.* Simon & Schuster.

3. Simpson, G.G. (1949). *The meaning of evolution, A Study of the History of Life and of Its Significance for Man*. Oxford University Press.

4. Milner, R. (1999). *Charles Darwin: Evolution of a Naturalist.* Universities Press.

5. Magguran, A.E. (1996). *Ecological diversity and its measurements.* Princeton University.

6. Gadgil, M. () *A methodology mannual for scientific inventorying, monitoring and conservation of Biodiversity*

7. *Planet Earth: The view from space*

8. Attenborough, D. *The private life of plants. 1st Edn.* BBC Worldwide Ltd.

9. Sutherland, W. (2006). *Ecological census technique: A Handbook, 2nd Edn.* Cambridge University Press.

10. Odum, E. and Barett, G. (2005). *Fundamentals of Ecology*. Thomson Brooks/Cole.

BD - TC 202: Quantitative Biology

A) Descriptive Statistics, Measures of central tendancies and Measures of Dispersion (1 credit)
   a. Need for statistics / application of statistics.
   b. Data classification and representation - Classification of data, tabulation, graphical representation.
   c. Measures of central tendencies and significance
   d. Measures of dispersion – absolute and relative and significance

B) Probability distribution and Hypothesis testing (1 credit)
   a. Probability distributions – binomial, poisson, normal.
   b. Non-Normal distributions
   c. Central limit theorem, confidence interval.
   d. Hypothesis testing and statistical inference, concept of Null hypothesis, significance level, Type I & II errors.

C) Comparison of means, Correlation, Regression (1 credit)
   a. t - test family – paired, unpaired.
   b. nonparametric tests – Mann Whitney U test, chi squared.
   b. Correlation - Pearson's correlation, Non-parametric correlation.
   c. Regression - Linear regression, Multiple regression.

D) Experimental Design, Factorial Experiments (1 credit)
   a. Factorial experiments, ANOVA, MANOVA.
   b. Experimental and Sampling design, CRD, RBD, Latin squares.
   c. Sampling strategies and selection of sampling strategies, Optimization of sample size.

E) Multivariate analysis (1 credit)
   a. Measuring and testing multivariate distances,
   b. Ordination and Principle Component Analysis
   c. Cluster analysis- strategies of clustering– merits & demerits.
   d. Construction of Dendograms, rooted and unrooted trees, interpreting phylogenetic relationships.

In semester evaluation - A mini project involving statistical designing of a mock project

Suggested readings :-

1. Gore, A. P. and Paranjpe, S. A. (2001). *A Course in Statistical Ecology*. Kluwer Academic Publishers, Holland.

2. Anderson, D.R.; Sweeney, D.J. and Williams, T.A.. (1994) *Introduction to Statistics: Concepts and Applications.* West Group.

3. Zar, J.H. (1999). *Biostatistical Analysis, 4th Edn*. Northern Illinois University.

4. Bailey, N.T.J. (1959). *Statistical methods in Biology*, English Universities Press Limited.

5. Sokal, R.. and Rohlf, F. J. (2012) *Biometry: Principles and practice of statistics in biological research, 4th Edn.* W. H. Freeman and Co**.**

6. Krantz, S.G. (1998). *A primer of mathematical writing,* American Mathematical Society.

7. Cochran, W.G. and Snedeco, G.W. (1967). *Statistical Methods, 7th Edn*. Ames, IA: lowa State University Press.

BD – TNC 203: Biogeography and Human Ecology

A) Biogeography   (1 Credit)
    a. Origin and development of the Earth, Geological time scale and development of life
    b. Phytogeography, Biomes
    c. Floristic regions and vegetation zones of Maharashtra and India.
    d. Zoogeographical realms, types & their characteristic faunal divisions
    e. Factors influencing distribution of plant and animal life

B) Patterns and types of distributions   (1 Credit)
    a. Present day plant and animal distributions (w.r.t. Western Ghats)
    b. Centers of dispersals and pattern of dispersal, Mobility and migration, Geographical checks or barriers to dispersal / movement.
    c. Patterns of distribution with examples.
    d. Adaptation and competition, Species range, territoriality.

C) (i) Speciation, Island Biogeography   (1 Credit)
    a. Meaning and scope, types of speciation.
    b. Variety of Island habitats, Problems of isolation, Hazards of island life.
    c. Opportunities for adaptive radiation.
    d. Case studies – real island, functional island, Island biodiversity models.
    (ii) Application of Biogeography - Application of biogeographical knowledge in the following fields - Introduction to Remote sensing and GIS.

D) Human Ecology I   (1 Credit)
    a. History of man – nature interactions, Role of bioresources in shaping human culture.
    b. Agriculture – Origin, Spread, Changes, Challenges.
    c. Animal Husbandry - Origin, Spread, Changes, Challenges.
    d. Human – nature conflict, Human impact on distribution, consequences.

E) Human Ecology II   (1 Credit)
    a. Natural resources : Overview and distribution
    b. Edaphic factors, socio-economic issues of biodiversity, success stories about restoration etc.
    c. Resource Use Patterns – Diversity, Specificity, Sustainable utilization of bioresources.

In semester evaluation – Case studies related to speciation, dispersal models etc.

Suggested readings :-

1. Mani, M.S. (1974). *Biogeography of India,1*st *Edn.* Springer.

2. Abele, L.G. (1982). *Systematics, the fossil record and biogeography.* Proceedings of the Biological Society of Washington 93(2): 362-372

3. Gadgil, M. et. al. A Methodology Manual for Documenting People's Priorities for Biodiversity and Conservation. *Shrustiygyaan.*

4. *A walk on the wild side (an information guide to National Parks and Wildlife Sanctuaries of Karnataka)*, Karnataka forest Department.

5. Malhotra, K.C. et. al. (2001). *Cultural and Ecological Dimensions of Sacred Groves in India.* INSA, New Delhi.

6. *Who's Eden?* An overview of community approaches to wildlife management. (1994) International institute of environment and development (IIED).

7. Ganguli, P. (1998). *Gearing up for Patents: The Indian Scenario.* Hyderabad Universities Press (India).

8. Chapman, J.L. and Reiss, M.J. (1998). *Ecology: Principles and applications.* Cambridge University Press.

BD - TNC 204 : Environmental Pollution and Climate Change

A) Introduction
   a. Environment and its definition, Natural resources: Overview and distribution, Biotic and Abiotic factors, Optimum use, overuse, Quality and Quantity of these resources-past and present
   b. Renewable and Non renewable resources
   c. Pollution and its definition, Types of pollution-Introduction, Manmade pollution

B) Soil Pollution
   a. Importance of the resource, Optimum use, overuse of the resource
   b. Causes – Natural and Manmade : deforestation, Over irrigation, use of chemical pesticides and fertilizers, urbanization, dumping
   c. Effects – soil erosion, reduction in fertility, Biomagnification, Salination, toxicity, its effects on soil life-forms, underground soil pollution and other short term and long term effects
   d. Remedies - Afforestation, less use of chemical pesticides and fertilizers, Solid waste treatment, optimum irrigation.
   e. Case study – Mining industries

C) Water Pollution
   a. Importance of the resource and its characteristics Optimum use, overuse of the resource
   b. Causes – Natural and Manmade : deforestation, Over irrigation, Agrochemicals, urbanization, Industrial waste, dumping of domestic sewage, Oil spills, Heavy metals, Thermal pollution
   c. Effects – Eutrophication, decrease in quality of water, toxicity, its effects on water life-forms, underground water pollution and other short term and long term effects
   d. Remedies - Afforestation, less use of chemical pesticides and fertilizers, Industrial effluent treatment, 5Rs (Refuse, Reduce, Reuse, Recycle and Recover)
   e. Case study – Ganga River pollution

D) Air Pollution
   a. Importance of the resource, Composition and pollutant
   b. Causes – Natural and Manmade : Forest fires, Agricultural pattern, Industrialization, Urbanization, dumping
   c. Effects – Ozone depletion, Increase in CO, Increase in particulate matter, Acid rain, Green house effect, Global warming, Effects on Wildlife, pollution and other short term and long term effects
   d. Remedies – Use of renewable resources, Less use of petroleum products.
   e. Case study – London Smog, Bhopal disaster

E) Climate Change
   a. Impact of climate change, Community response and Government policies, Ecological footprint, Clean Development Mechanism (CDM)
   b. Earth summit, Kyoto protocol, Framework convention on Climate change (UNFCCC)

Assignments: Review writing on effect of climate change on biodiversity, Case studies on soil erosion control techniques, review on bio indicators of water quality

Suggested readings :-

1. Watt, K.E.F. (1973). *Principles of Environmental Science*, McGraw – Hill Book Company

2. Kumar, H. (2001). *Environmental Health Hazards*, Ivy Publishing House, Delhi.

3. Desai, A. V. (1990). *Energy Economics*, Wiley Eastern, Bombay

4. Mittal, K. M. (1997). *Non-conventional Energy System*, Wheeler publisher, New Delhi.

5. Trivedi, R. K. and Goel P. K. (1980). *Chemical and Biological method for water pollution studies*, *Environmental Publications Karad*, India 215.

6. Santra, S. C. (2001). *Environment Science*, New Central Book Agency (P) Ltd.

7. Agarwal, K. C. (1989), *Environmental Biology*, Agrobotanical Publishers

8. Todd, D.K. (1980). *Ground water Hydrology*, John Willey & sons publishers, New York.

9. Achanta,A.N. (1993). *Climate Change Agenda: An Indian Perspective*, Tata Energy Research Institute, New Delhi.

10. Tuve,G.L. (1976). *Energy, Environment, Population and Food: Our Four Interdependent Crisis,* John Wiley & Sons Inc., New York

BD – PC 211: Field Ecology Techniques

(1 Credit)

a. Introduction to sampling and sample size.

b. Sampling units- Quadrats & Transects

c. Sampling of various life forms (herbs, shrubs, trees, lianas)

(1 Credit)

d. Species area curve, species abundance distribution,

e. Girth class distribution, Regeneration

(1 Credit)

f. Estimation of IVI, FIV

g. Biomass estimation

h. Estimation of Ecological indices

(1 Credit)

i. Estimating bird, insects, mammal densities using appropriate strategies

(1 Credit)

j. Introduction to Maps – Contours, Field Maps

k. Study of SOI Toposheets and its use in sampling

l. Use of Compass & GPS for making field maps

BD - PC 212: Quantitative Techniques in Ecology

(1 Credit)

a. Introduction to computers

b. Introduction to Excel. Use of spreadsheets

c. Use of excel in univariate analysis

(1 Credits)

d. Indices of α-diversity, species rarefaction

e. β-diversity similarity & dissimilarity indices

(1 Credit)

f. Use of BD Pro, PAST

g. Statistical packages for performing statistical tests

h. Use of clustering algorithms.

(1 Credit)

i. Determining allelic frequencies in a population

j. Growth curve

k. Simulation models of growth and population interactions

(1 Credit)

l. Methods of estimating population densities and population growth rates in plants, animals and microorganisms, optimum harvesting and sustainability