

**ASSAM UNIVERSITY, SILCHAR**

**SYLLABUS  
FOR**

**M.Sc Programme in Ecology and Environmental Science  
Choice Based Credit System (CBCS)**



**Department of Ecology and Environmental Science  
School of Environmental Sciences**

**2010**

**DEPARTMENT OF ECOLOGY AND ENVIRONMENTAL SCIENCE  
ASSAM UNIVERSITY, SILCHAR**

**M.Sc Programme in Ecology and Environmental Science (Two Years Course)  
Choice Based Credit System (CBCS)**

| <b>Semester</b> | <b>Course Number</b> | <b>Course Name</b>   | <b>Sessional</b> | <b>End Sem</b> | <b>Credit</b> | <b>Total</b> |
|-----------------|----------------------|--|------------------|----------------|---------------|--------------|
| I               | ECG-101              | Ecosystem Analysis   | 25               | 75             | 5             | 100          |
|                 | ECG-102              | Population and Community Ecology                           | 25               | 75             | 5             | 100          |
|                 | ECG-103              | Natural Resource Management and Remote Sensing Application | 25               | 75             | 5             | 100          |
|                 | ECG-104              | Statistics and Computer Applications in Ecology            | 25               | 75             | 5             | 100          |
|                 | ECG-105              | Practical on ECG-101 and ECG-102                           | 12.5             | 37.5           | 2.5           | 50           |
|                 | ECG-106              | Practical on ECG-104                                       | 12.5             | 37.5           | 2.5           | 50           |
| II              | ECG-201              | Freshwater Ecology   | 25               | 75             | 5             | 100          |
|                 | ECG-202              | Biodiversity Conservation                                  | 25               | 75             | 5             | 100          |
|                 | ECG-203              | Climate Change- Choice based                               | 25               | 75             | 5             | 100          |
|                 | ECG-204              | Forest Ecology   | 25               | 75             | 5             | 100          |
|                 | ECG-205              | Practical on ECG-201                                       | 12.5             | 37.5           | 2.5           | 50           |
|                 | ECG-206              | Practical on ECG-202 & ECG-204                             | 12.5             | 37.5           | 2.5           | 50           |
| III             | ECG-301              | Behavioural and Wildlife Ecology                           | 25               | 75             | 5             | 100          |
|                 | ECG-302              | Pollution Ecology and Environmental Impact Analysis        | 25               | 75             | 5             | 100          |
|                 | ECG-303              | Environmental Policy, Education and Ethics- Choice based   | 25               | 75             | 5             | 100          |
|                 | ECG-304              | Soil, Microbial and Agricultural Ecology                   | 25               | 75             | 5             | 100          |
|                 | ECG-305              | Practical on ECG- 301 and ECG- 302                         | 12.5             | 37.5           | 2.5           | 50           |
|                 | ECG-306              | Practical on ECG- 304                                      | 12.5             | 37.5           | 2.5           | 50           |
| IV              | ECG-401              | Human, Rural and Urban Ecology                             | 25               | 75             | 5             | 100          |
|                 | ECG-402              | Environmental Biotechnology and Eco restoration            | 25               | 75             | 5             | 100          |
|                 | ECG-403              | Special Paper (403A/B/C/D/E/F)                             | 25               | 75             | 5             | 100          |
|                 | ECG-404              | Practical on Special Paper (403A/B/C/D/E/F)                | 12.5             | 37.5           | 2.5           | 50           |
|                 | ECG-405              | Projects on Special Paper (403A/B/C/D/E/F)                 | 37.5             | 112.5          | 7.5           | 150          |

**\*Special Papers:**

**Total credit-100  
Total Marks-2000**

**ECG 403A: Microbial ecology**  
**ECG 403B: Environmental monitoring and management**  
**ECG 403C: Forest and agricultural biodiversity and ecology**  
**ECG 403D: Pest management and ecotoxicology**  
**ECG 403E: Algal ecology and physiology**  
**ECG 403F: Wildlife conservation ecology**

## **Scheme of Evaluation**

- (a) Each theory paper shall carry 100 marks of which 25 shall be reserved for Internal assessment of sessional work, comprising three tests. End semester examination in each course paper shall have a question carrying 75 marks. The question paper shall have five questions, of equal weightage, each with an alternative, thus allowing only internal choice. Equal weightage is given to all units.
- (b) For practical papers 25 percent mark is allotted for internal assessment and 75 percent for end semester examination. End semester practical examinations are evaluated by external and internal examiners.
- (c) Each student has to opt for a special paper in fourth semester. Student has to submit a project, which involves primary/secondary data collection, analysis and submission of dissertation. The project is evaluated by external and internal examiners. The students are required to deliver a seminar on this project and defend before the examiners.

**ECG – 101**  
**ECOSYSTEM ANALYSIS**

**Lectures 45    Credit 5    Marks 100**

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- Unit I**      Ecology: Basic concepts; scope; multidisciplinary nature and relevance; biosphere and ecosystem; the biosphere concept and its significance; concept, organization and significance of ecosystems; cybernetic nature of ecosystems.
- Unit II**      Factors affecting ecosystem: Major environmental factors (biotic and abiotic)-influences on organism at various ecosystems; concept of limiting factors; Liebig law of the minimum; Shelford law of tolerance.
- Unit III**     Energy flow and trophic dynamics: Energy flow in ecosystems; concept of trophic dynamics and trophic cascade; food chains, food webs and trophic levels; ecological pyramids; energy transfer; ecological efficiencies; biogeochemical cycles (water, oxygen, carbon, nitrogen, phosphorus and sulphur) and man's impact.
- Unit IV**     Productivity: Primary and secondary productivity; methods of estimating productivity; factors affecting primary productivity; world patterns of primary productivity; man's exploitation of primary and secondary production.
- Unit V**      Evolutionary Ecology: Natural Selection and its ecological significance, modern concept of species, adaptation; significance of mutation, isolating mechanism and ecological role and other evolutionary processes in ecology.

**Essential readings:**

- Ambasht R S and Ambasht, N K (2008). *Text book of plant ecology* (15<sup>th</sup> edition). CBS Publishers and Distributers ,New Delhi.
- Colbert, E.M. (1996). *Evolution of the vertebrates; A history of backboned animals through times.*Wiley Eastern Ltd., New Delhi.
- Dobzhansky, T. (1973). *Genetics and the origin of species.* Oxford & IBH Publishing Co.
- Gupta, P.K. (1990). *Cytology, genetics, evolution and ecology.* Rastogi Publications, Meerut.
- Kormondy, E J (1996). *Concepts of ecology* (4<sup>th</sup> ed.). Prentice-Hall of India Pvt. Ltd.
- Krebs, C J (1985). *Ecology-the experimental analysis of distribution and abundance.* Harper and Row, New York.
- Lull, R.S. (1976). *Organic Evolution* (revised India edn). Suma Publications, Delhi.
- Narwal S.S. and Palrick T.(1994). *Allelopathy in Agriculture and Forestry.* Scientific Publishers.
- Odum E P (1983). *Basic Ecology.* Saunders College Publications, Japan.
- Odum, E P (1971). *Fundamentals of Ecology.* W B Saunders, Philadelphia.
- Singh, J.S; Singh, S.P. and Gupta S.R. (2006). *Ecology, environment and resource conservation.* Anamaya Publishers, New Delhi.

**Additional readings:**

- Brewer, R. (1994 ).*Principles of ecology.* Saunders College Publishing, London.
- Cerpenter, S. R. and Kitchell, J. F. (1993).*The trophic cascade in lakes.* Cambridge University Press, New York. USA.
- Dash, M.C.and Dash,S.P. (2009). *Fundamentals of ecology* (3<sup>rd</sup> edition). Tata McGraw-Hill Publishing Co., New Delhi.
- Degens, E.T. (1989). *Perspectives on biogeochemistry.* Springer Publication. NewYork.
- Kumar, H.D (1995). *Modern concepts in ecology.* Vikas Publishing House, New Delhi.
- Nobel, B.J. and Wright, R.T. (1995). *Environmental science.* Prentice Hall.
- Santra, S.C. (2005). *Environmental science* (second edition) . Central Book Agency, Calcutta.
- Wratten, S. D (1988). *Principles of ecology.* Chapman and Hall, NewYork.

**ECG – 102**  
**POPULATION AND COMMUNITY ECOLOGY**

**Lectures 45    Credit 5    Marks 100**

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- Unit I**      Attributes of population: Population growth, density; density dependent and density independent factors; natality, mortality, biotic potential, carrying capacity; survivorship and age structure; seasonal population fluctuation.
- Unit II**      Population energetics and interactions: Population energetics; patterns of populations, aggregation and Allee's principle; population interactions, competition (allelopathy); parasitism, predation, herbivory; protocoeperation, commensalisms, mutualism.
- Unit III**     Community ecology: Community concept; ecological niche; individualistic and organismic nature of communities; qualitative and quantitative characters of community; methods of studying vegetation; species diversity and stability relationship; diversity indices.
- Unit IV**     Succession and climax: Types of succession, trends of succession; models of succession; concept of climax community; theories on climax, ecotone and edge effect; ecotypic differentiation; r and k strategies.
- Unit V**     Terrestrial and aquatic communities: Plant and animal communities in forest, grassland, desert and mangrove ecosystems; high altitude communities; zonation and stratification of plant and animal communities.

**Essential readings:**

- Begon, M. ; Harper, J.L. and Townsend, C.R. (2006). *Ecology: individuals, populations and communities*. Blackwell Scientific Publications.
- Barnes, R. S.K. and Hughes, R.N. (2000). *An introduction to marine ecology*, Blackwell Publicaitons.
- Boughey, A. S (1968). *Ecology of populations*, McMillan, NewYork.
- Chapman, J.L.K. and Reiss, M.J. (1997). *Ecology: principles and applications*, Cambridge University Press.
- Dash, M.C.and Dash,S.P. (2009). *Fundamentals of ecology* (3<sup>rd</sup> edition). Tata McGraw-Hill Publishing Co., New Delhi.
- Kormondy, E.J. (1996). *Concepts of ecology* (4<sup>th</sup> Edn) Prentice Hall of India, New Delhi.
- Mueller D. and Ellenberg H.(1974). *Aims and methods of vegetation ecology*. John,Wiley & Sons.
- Narwal S.S. and Patrick T.(1994). *Allelopathy in agriculture & forestry*. Scientific Publishers, Jodhpur.
- Odum, E.P. and Barrett, G.W. (2005). *Fundamentals of ecology* (5<sup>th</sup> Edition) .Thompson.
- Putman, R.J. (1993). *Community ecology*. Chapman and Hall, NewYork.
- Stiling, Peter (2002).*Ecology: theory and practice* (4<sup>th</sup> Edn.). Prentice Hall of India.
- Silverton, J.W. (1982). *Introduction to plant population*. Longman.
- Singh, J.S., Singh, S.P. and Gupta, S.R. (2006). *Ecology, environment and resource conservation*. Anamaya Publishers, New Delhi.

**Additional readings:**

- Girme, J P (1979). *Plant strategies and ecosystem processes*. John Wiley and Sons, New York.
- Inderjit, Dakshini, K.M.M. and Chesler L. Foy (1999). *Principles and practices in plant ecology: allelochemical interactions*. CRC.press.
- Moss, R. (1983). *Animal population dynamics*. Chapman and Hall, New York.
- Sharma, P.D. (2009). *Ecology and environment* (10<sup>th</sup> edition). Rastogi Publication, Meerut.

- Unit I** Resource: Definition, category, concept and scarcity of resource; mineral resource, types and reserves, mineral resources in oceans; fossil fuel reserves, types and uses, processing and smelting of ores; energy content and physicochemical characteristics of fossil fuel; nuclear energy.
- Unit II** Renewable energy resource : Energy use, solar energy; hydroelectric power generation; tidal energy; wind energy; geothermal energy; energy from biomass; energy conservation.
- Unit III** Land and soil resource: Land as a resource; land use pattern in India; soil types of India; soil degradation, soil erosion, desertification; soil conservation and management strategies.
- Unit IV** Water resource: Water resource potentials and use (Freshwater, marine and brackish) with special reference to India; rainwater harvesting and ground water resource and management; impending water crisis and the Indian scenario; concept of Integrated Water Resources Management (IWRM).
- Unit V** Remote Sensing and GIS: Principles and concept of remote sensing; introductory image processing techniques; application of remote sensing; GIS technology; applications of GIS; Landscape and ecosystem processes.

**Essential readings:**

- Burrough P.A.; and Mc.Donnell R. A.(1998). *Principles of Geographical Information Systems* (2<sup>nd</sup> edition), Oxford University Press.
- Dasman, R.F. (1983). *Environment conservation*, John Wiley and Sons, New York.
- Farina, A. (2000). *Introduction to landscape ecology*. Kluwer Academic Publisher, USA.
- Gangstad, E.O. (1990). *Natural resource management of water and land*. Van Nostrand Reinhold, NewYork.
- Gardner, R.H., Robert, V., O'Neill and Turner, M.G. (2001). *Landscape ecology in theory and practice: pattern and process*. Springer-Verlag, USA.
- Jensen J. R. (2005). *Introductory digital image processing: a remote sensing perspective*. (2<sup>nd</sup> edition). Prentice Hill Inc.
- Joseph G (2005). *Fundamentals of remote sensing*(2<sup>nd</sup> edition). University Press .
- Lillesand T. M.;Kiefer R. W. and Chipman J.W.(2004).*Remote sensing and image interpretation*(5<sup>th</sup> edition) .Wiley India.
- Mather , A.S. and Chapman, K.(1996) . *Environmental resources*. Pentice Hall.
- Middleton, N. (1995) .*The Global casino*.Edward, London.
- Ramade, F. (1983). *Ecology of natural resources*. John Wiley and Sons.
- Ryszkowski, L. (ed.)(2002). *Landscape ecology in agroecosystem management*. CRC press, USA.
- Sehgal J. and Abrol, I.P.(1994). *Soil degradation in India*. Oxford and IBH Publishing Company, New Delhi.
- Schlager, N. and J. Weisblatt (2006). *Alternative energy* (vol. 1,2 and 3). Thomson and Gale.
- Singh, J.S., Singh, S.P. and Gupta, S.R. (2006). *Ecology, environmental and resource conservation*. Anamaya Publishers, New Delhi.
- Turner, M.G. and Gardner, R.H.(1994). *Quantitative methods in landscape ecology: the analysis and interpretation of landscape heterogeneity*. Springer- Verlag Publishers, USA.

**Additional readings:**

- Pawar. S.H. and Ekal, L.A (2003). *Advances in renewable energy technologies*. Narosa Publishing House.
- Rajendran, S. (2007). *Mineral exploration: recent strategies*. New India Publishing, New Delhi.
- Shastree, N.K. (1997). *Environmental resource management*, Anmol Publication, New Delhi.
- Tiwari, G.N. and Ghosal, M.K. (2005). *Renewable energy resources; Basic principles and application*. Narosa Publishing House Pvt.Ltd.

**Group-A (Statistics)**

- Unit I**      Descriptive statistics: Concepts of statistical ‘Population’ and ‘Sample’ from a population; simple random sampling, collection and scrutiny of data, frequency distribution, graphical/representation of data; measures of central tendency: mean, median and mode; measures of dispersion; range, mean deviation, standard deviation, coefficient of variation, moments, skewness and kurtosis.;correlation and regression; coefficient of correlation, partial and multiple correlations.
- Unit II**      Probability theory and probability distributions: Probability theory; random experiment, classical and statistical definitions of probability; theorems of total probability, conditional probability and the theorem of compound probability; statistical independence of events, random variable and its expectation and variance; probability distributions; binomial and poisson distribution, definition, derivation of mean and variance; normal distribution, definition and statement of properties, probability calculations with normal distribution.
- Unit III**      Test of significance: Test of hypothesis; null and alternative hypothesis, type I and type II errors; power of a test, Statements of Chi-square, t and F statistics, important parametric tests for hypotheses (Z, t and F tests); designs of experiment; ANOVA one-way and ANOVA two-way; basic principle of designs like randomization, replication and local control.

**Group-B (Computer applications)**

- Unit IV**      Introduction to computing: Generation of computers and their classification; basic concepts of a computer and its overall working, building blocks of a computer, concepts of hardware and software, memory; primary and secondary memories, different input, output and peripheral devices, classification of software; introduction to operating systems, functions of and operating system, different types of operating system; an overview of MS-DOS, concept of windows, linux, concept of GUI, concepts of multi-user and multi tasking systems.
- Unit V**      Data communication and networking: Networking topologies, ISO-OSI model, the LAN, WAN and TCP/IP concepts; basic concepts of DBMS data, database, data versus information; metadata, advantages of database, objectives of DBMS, components of DBMS -entities, attributes, relationships.

**Suggested readings:**

- Bishop, O.N. (1980). *Statistics for biology*. Longman, London.
- Bhattacharjee, D. and Bhattacharjee D. (2010). *B.Sc statistics* Vol. I and Vol. II Kalyani Publishers, Ludhiana, India.
- D’Souza (2004). *Learn computers step by step*. Pearson Education.
- Gupta, S.C. and Kapoor, V.K. (1994). *Fundamentals of mathematical statistics*. Sultan Chand and Co.
- Goon, A.M.; Gupta, M.K. and Dasgupta, B. (1996). *Basic statistics* vol. I and II, The World Press Pvt. Ltd.



Heon, A. *Internet for everyone*. Leon Techworld, New Delhi.  
Parker, R.E. (1979). *Introductory statistics for biology*, Edward Arnold, London.  
Rajaraman, V. *Fundamentals of computer*. Prentice Hall of India.  
Snedecor, G.W. and Cochran, W.G. (1967). *Statistical methods*, Oxford and IBH, New Delhi.  
Saxena, S. (1998). *A first course in computer*. Vikas Publishing House Pvt. Ltd.  
Snedecor, G.W. and Cochran, W.G. (1989). *Statistical methods*, Affiliated East West press.  
Sinha, P.K. & Sinha P. (2002). *Foundations of computing* (third edition). Bpb, Publication  
Watt, T.A. (1993). *Introductory statistics for biology students*. Chapman and Hall, New York.  
Williams, B.G. (1993). *Biostatistics*. Chapman and Hall, New York.  
Zar, J.H. (2003). *Biostatistical analysis*, Pearson Education.

**Additional readings:**

Gomez, K.A and Gomez, A.A. (1984). *Statistical procedures for agricultural research* (2<sup>nd</sup> edition) John Wiley and Sons  
Panse, V.G and Sukhatme, P.V. (1978). *Statistical methods for agricultural workers*. Indian Council of Agricultural Research.  
Williams, B.G. (1993). *Biostatistics*. Chapman and Hall, New York.  
Zar, J.H. (2003) *Biostatistical analysis*. Pearson Education.

### List of practicals

01. Determination of abiotic factors in terrestrial ecosystems.
02. Ground mapping with prismatic compass.
03. To develop a correlation between leaf size and leaf area of a given species.
04. Determination the of pattern of biomass allocation in a grassland community.
05. Estimation of net primary productivity (NPP) of a grassland community.
06. Studies on consumer community in a terrestrial ecosystem.
07. To demonstrate the working of bomb calorimeter for determining energy content of plant material.
08. Estimation of population size by quadrat method.
09. Observations on the allelopathic interactions among plants.
10. Methods of vegetation sampling.
11. Estimation of quantitative parameters in a community.
12. Estimation of patterns of distribution of species in a community.
13. Estimation of canopy cover using spherical densiometer.
14. Analysis of zooplankton community in an aquatic ecosystem.
15. Studies of lichen community in different habitats.

### Essential readings:

- Awasthi, D.D (2000). *Lichenology in Indian subcontinent*. Bishen Singh Mahindra Pal Singh, Dehradun.
- Brewer, R. and McCann, M.T. (1982). *Laboratory and field manual of ecology*, Saunders College Publishing.
- Michael, P. (1984). *Ecological methods for field and laboratory investigation*. Tata McGraw-Hill, New Delhi.
- Moore, P.D. and Chapman, S.B. (1986). *Methods in plant ecology*. Blackwell Scientific Publications.
- Misra, R. (1968). *Ecology work book*, Oxford and IBH Publishing Co. Calcutta.
- Mueller-Dombois, D and Ellenberg, H. (1974). *Aims and methods of vegetation ecology*. John Wiley and Sons, New York.

**Group-A (Statistics)**

**List of practicals:**

1. Construction of frequency distribution and calculation of frequency, cumulative frequency, relative frequency etc.
2. Tabulation of data: preparation of blank table and filled table.
3. Graphical representation of data through various types of bar diagrams and pie diagram.
4. Graphical representation of frequency distribution through histogram, frequency polygon and ogive. Determination of mode and median and other measures of location graphically.
5. Calculation of central values of a statistical data using various measures of central tendency for grouped and ungrouped frequency distributions (including measures of location)
6. Calculation dispersion of a given dataset using various absolute measures.
7. To calculate the dispersion in more than one data set using relative measures of dispersion.
8. Calculation of combined mean and combined variance of two samples.
9. Calculating the correlation between two samples using (i) direct method (ii) changing origin and scale method.
10. Calculating correlation between two samples and also finding the lines or regression. Estimating the values of the dependent variable from the lines of regression.
11. Estimating the parameters and fitting a binomial distribution to a given data.
12. Estimating the parameter and fitting a Poisson distribution to a given data.
13. Test of significance for difference between sample proportion and population proportion.
14. Test of significance for difference between two sample proportions.
15. Test of significance for difference between a sample mean to its population mean.
16. Test of significance for difference between two sample means.
17. Test of significance for difference between two sample standard deviations.
18. Test of significance sample correlation coefficient.
19. t-test for significant difference between two sample means
20. t-test for significant difference two sample means
21. Paired t-test for difference between sample means.
22. F-test for significant difference between two sample variances.
23. Chi-square test for goodness of fit.
24. Chi-square test for independence between attributes in a contingency table.
25. Chi-square test for significant difference between sample variance and population variance.
26. ANOVA for one way classified data.

## Group-B (Computer applications)

1. MS-DOS
2. MS-WINDOWS
3. Introduction to word processing: MS-word, concepts of toolbars, menu bars, spelling and grammar checking, table creation, entry of text, mail merge and also accessing of different utilizer.
4. Introduction to spreadsheet of worksheet: tool bars, menu bars, opening a new worksheet, entry of text/numeric data. Use of functions mathematical operators; edit formula bar, concepts of different charts, and Mathematical applications of worksheet.
5. MS-Power point: Organisation charts clip art, slide show, working with power point, animation and sound effects.
6. Introduction to MS-Access: Creation of databases, tool bars, menu bars, opening of a data bar, entry format, entry of data, saving and formatting of data, queries of data, sorting of data,etc.

### Essential readings:

Goon, A.M.; Gupta, M.K. and Dasgupta, B.(1996). *Basic statistics* Vol.I and II. The World Press Pvt.Ltd.

Saxena, S. (1998). *A first course in computers*. Vikas Publishing House Pvt. Ltd.

Sinha, P.K. and Sinha P. (2002) .*Foundations of computing* (3<sup>rd</sup> edition). Bpb, Publication.

## FRESHWATER ECOLOGY

Lectures 45 Credit 5 Marks 100

- Unit I** Lentic ecosystem: Types, formation; distribution,; zonation and stratification; classification of lakes; ecology of major lakes of India; ecology of artificial reservoirs; ecology of high altitude lakes.
- Unit II** Wetlands: Definition and classification of wetlands; values of wetlands; floodplain wetlands of Assam; conservation and restoration of wetlands; national and international efforts.
- Unit III** Lotic ecosystem: Types, zonation and classification; ecology of rivers of India; ecology of hyporheic zone; watershed and river continuum concept; flood-ecology and management.
- Unit IV** Ecological processes: Environmental factors operative in freshwater ecosystems; nutrient processing; nutrient cycling; productivity of freshwater ecosystem.
- Unit V** Ecology and conservation of freshwater communities: Phytoplankton, periphyton and macrophytes; zooplankton, insects and other invertebrates; fishes and other vertebrates; ecological issues in aquaculture.

**Essential readings:**

- Barnes, R.S.K. and Mann, K.H. (1991). *Fundamentals of aquatic ecology* (2<sup>nd</sup> edition). Blackwell Science.
- Battish, S.K.(1992). *Freshwater zooplankton of India*. Oxford & IBH Publishing Co. New Delhi.
- Hynes, H B N (1970). *The ecology of running waters*, Liverpool University Press.
- Hynes, H B N (1960). *The ecology of polluted waters*. Liverpool University Press.
- Odum, E.P. *Fundamentals of ecology* (3<sup>rd</sup> edition). W.B.Saunders Company, London.
- Resh, V H and Rosenderg, D M (eds.) (1984). *The ecology of aquatic insects*. Praeger, New York.
- Round, E E (1981) . *The ecology of algae*, Cambridge University Press, Cambridge.
- Smith, G W (1950). *The freshwater algae of the United States* (2<sup>nd</sup> edition). McGraw Hills Book Co. Inc., New York.
- Williams, D D (1987). *The ecology of temporary waters*. Chapman and Hall, New York.
- Wetzel, R G and Likens, G E (1979). *Limnological analysis*. W B Saunders Company, Philadelphia
- Wetzel, R.G. (2001) .*Limnology* ( 3<sup>rd</sup> edition). Saudners College Publishing, Philadelphia.

**Additional readings:**

- Allan, J.D and Casti Uo, M.M. (2007).*Stream ecology: structure and functioning of running waters*.( 2<sup>nd</sup> edition). Springer Publishers.
- Closs. Gerry, Bownes, Barbara and Boutton. Andrew (2004). *Freshwater ecology: a scientific introduction*. Blackwell Science Limited.
- Cummins, K W (1995). *Lotic limnology*. Chapman and Hall, New York.

- Datta, Munshi. (1995). *Fundamentals of freshwater biology*. Narendra Publishing House, New Delhi.
- Gopal, B (1995). *Handbook of wetland management*. WWF, India, New Delhi.
- Gopal, B (1995). *Limnology in developing countries*. NIE New Delhi.
- Houer, F.R and Lamberti, G.A. (2007). *Methods in stream ecology* ( 2<sup>nd</sup> edition). Elsevier.
- Jeffries, M. and Mills, D. (1992). *Freshwater ecology: principles and applications*. CBS Publishers.
- Lampert, W and Sommer, U. (2007). *Limnoecolgy* ( 2<sup>nd</sup> edition). Oxford University Press.
- Rath, R.K. (2000). *Freshwater aquaculture*, Scientific Publishers.
- Schwoerbel, J. (1991). *A handbook of limnology*. Scientific Publishers.
- Santra, S.C. (2004). *Environmental science*. New Central Book Agency (P) Ltd. Kolkata.
- Wetzel, R.G.( 2001). *Limnology. Lake and river ecosystems*. (3<sup>rd</sup> edition). Elsevier Science, USA.
- Whitton, B A (1975). *River ecology*. Blackwell Scientific Publications, Oxford.

**ECG – 202**  
**BIODIVERSITY CONSERVATION**  
**Lectures 45**

**Credit 5**      **Marks 100**

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- Unit I**      Basic concepts of biodiversity conservation: Biodiversity- definition, levels and types; latitudinal and altitudinal gradients of biodiversity; biodiversity and extinctions; history of biodiversity conservation; biodiversity conservation strategies-*in situ* and *ex situ* conservation; biodiversity values-evolutionary, economic, social, cultural and intrinsic values.
- Unit II**      Global approaches to biodiversity conservation: Climate change and biodiversity; millenium ecosystem assessment (MEA); millenium development goals (MDG) in biodiversity; convention on biological diversity (CBD); biodiversity and ecosystem services; international programmes for biodiversity conservation.
- Unit III**      Biodiversity of Indian subcontinent: Indian initiatives in biodiversity conservation- biodiversity act 2002, national biodiversity strategy and action plan (NBSAP), national biodiversity authority (NBA) etc; threats to biodiversity-Indian context; protected area network (PAN)-biosphere reserves, national park, sanctuary, community conservation area, important bird areas, ecological sensitive zone; biodiversity hotspots, their characteristic flora and fauna.
- Unit IV**      Biodiversity resources of north-east India: Plant and microbial diversity of north east India; threatened vascular plant species in India; biological invasions; animal diversity-micro and macro fauna; important protected areas of north east India; biodiversity conservation in barak valley- problems and prospects.
- Unit V**      Indigenous approaches to biodiversity conservation: Sacred groves (Forests); ecosystem people and nature; biodiversity & ethnomedicinal resources- their collection and conservation mechanisms; ethnobotanical studies in N.E. India; intellectual property rights and traditional knowledge ; ethnobotany in the conservation of plant genetic resources; traditional knowledge digital library (TKDL).

**Essential readings:**

Cotton, C.M. (1997). *Ethnobotany principles and applications*. John Wiley & Sons New York.

Huston, M.A. (1995). *Biological diversity*. Cambridge University Press.

Jain S.K. (1995). *A manual of ethnobotany*. Scientific Publisher's (India, Jodhpur).

Mandal, F.B and Nandi, N.C. (2009). *Biodiversity concept, conservation and bioculture*. Asian Books Ptd. Ltd.

Pimental, D.( 2002). *Biological invasions*, CRC Press, New York.

Sinha R.K and Sinha, S. (2001). *Ethnobiology*. Swastik Publicaitons, Jaipur.

Sharma, P.D.(1996). *Ecology and environment*. Rastogi Publications, Merrut.

**Additional readings:**

Freedman, B. (1995). *Environmental ecology-the ecological effects of pollution, disturbance and other stresses*. Academic Press, New York.

Gaston, K.G. (2004). *Biodiversity: an introduction* (2<sup>nd</sup> edition). Blackwell Science Ltd.

Geethabali, R.R.(2002). *Biodiversity: monitoring, management, conservation and enhancement*. APH Publishing, New Delhi.

**ECG – 203**  
**CLIMATE CHANGE**

**Lectures 45 Credit 5 Marks 100**

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- Unit I** Basic concepts and mechanisms: Climate change, global warming and greenhouse effect; earth's natural greenhouse effect, the radiative balance; earth's carbon reservoirs and carbon cycle; climate and weather; El-Nino and La Nino; measurement of climate change; greenhouse gases in the atmosphere – sources, levels and mechanisms of action.
- Unit II** Effects: Rise in earth's temperature; effects on forests; effects on agroecosystems; desertification; effects on freshwater ecosystems; effects on oceans; sea level rise; melting of polar ice and glaciers; effects on rainfall patterns; socio-economic and public health consequences.
- Unit III** Mitigation and adaptation: Carbon storage and sequestration, carbon management through abiotic sequestration; oceanic injection, geologic injection, scrubbing and mineral carbonation; carbon management through biotic sequestration; forest ecosystems, wetlands; soil carbon sequestration; biofuels, carbon farming and carbon trading.
- Unit IV** The Indian scenario: Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change; India's position and actions vis-a-vis international programmes (UNFCCC, CDM and Kyoto Protocol, REDD+, Copenhagen Accord, etc.).
- Unit V** International response: Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol; the bali road map; The Copenhagen Accord; future actions; ethics of climate change.

**Essential readings:**

- Akimasa Suni, Kensuke, F., and Ai, Hiramatsu.(2010). *Adaptation and mitigation strategies for climate change*. Springer.
- Burroughs, W.J. (2007). *Climate change: A multidisciplinary approach* (2<sup>nd</sup> edition.). Cambridge University Press.
- Dash, Sushil Kumar. (2007). *Climate change: An Indian perspective*. Cambridge University Press India Pvt. Ltd. New Delhi.
- IPCC,(2007): *Summary for policymakers. In: Climate change 2007:impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7- 22.
- IPCC, (2007): *Summary for policymakers. In: Climate change 2007: mitigation. Contribution of working group III to the fourth assessment report of the intergovernmental panel on climate change* [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge university press, Cambridge, United Kingdom and New York, NY, USA.



IPCC, 2007: *Summary for policymakers. In: Climate change( 2007): The physical science basis. contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Kibria, G., Haroon, A.K.Y., Nugegoda, D. and Rose, G. (2010). *Climate change and chemicals: environmental and biological aspects*. New India Publishing Agency (NIPA).

**Additional readings:**

Gautam, P.L. Singh, V. and Melkania, U. (Eds.). (2009). *Ecosystem diversity and carbon sequestration: climate change challenge and a way out for ushering in a sustainable future*. Daya Publishing House, Delhi.

Ravindranath,N.H., Ravindranath, N. and Sathaye, J.A.(2002). *Climate change and developing countries*.Kluwer Academic Publishers.

Sarkar,A.N. (2010). *Emissions trading and carbon management*. Pentagon earth.

- Unit I** Forest and forest environment: Structure of forest ecosystem; forest microclimate; major forest types of the world; forest types and forest cover of India with special reference to North East India; tree cover of India.
- Unit II** Ecophysiology of forest trees: Characteristic of tropical trees; shoot growth in forest trees; phenology of trees; forest seed dormancy and germination; regeneration ecology of forest trees.
- Unit III** Forest ecosystem function: Primary productivity of forest ecosystems; methods of measurement; productivity patterns; litter production and decomposition; nutrient cycling and nutrient conservation strategies; forest hydrology.
- Unit IV** Forest ecosystem management: History of forest management in India; joint forest management; forest fire; behaviour and effects; plantation forestry; application of remote sensing technique in forest ecology; deforestation and approaches to forestry conservation; sustainable forest management.
- Unit V** Forest laws: Indian forest act; forest conservation act; forest rights act; social forestry; urban forestry; non timber forest products; pests and diseases of forest trees.

**Essential readings:**

- Barnes, B V; Zak, D R; Denton, S R and Spurr, S R (1998). *Forest ecology* (4<sup>th</sup> edition). John Wiley and Sons.
- Champion, H.G. and Seth, S.K. (1968). *A revised survey of the forest types of India* (Reprinted 2004). Natraj Publicaiton, Dehradun.
- Diwedi, A P (1993). *Forestry in India*, Surya Publications, Dehradun.
- Evans, J. and Turnbull, J. (2004). *Plantation forestry in the tropics* (3<sup>rd</sup> Edition). Oxford University Press
- FSI (2009). *State of forest report 2009*. Forest Survey of India, Dehradun.
- Kimmins, J.P. (2004). *Forest ecology* (2<sup>nd</sup> edition). Pearson Education.
- Newton, A. (2007). *Forest ecology and conservation*. Oxford University Press.
- Raymond, Y.A. and Ronald G.L. (2003). *Introduction to forest ecosystem: science and management* (3<sup>rd</sup> edition ).John Wiley and sons.
- Richards, P W (1996). *The tropical rain forest* (2<sup>nd</sup> edition). Cambridge University Press.
- Whitmore, T.C. (1998) .*The tropical rain forest*. Oxford University Press.

**Additional readings:**

- Anonymous (2004).*The Indian Forest Act, (1927) along with Forest Conservation Act 1980*, Natraj Publishers, Dehradun.
- Bakshi, B.K., Ram Reddy, M.A., Puri, Y.N. and Singh, S. (1972). *Survey of the diseases important native and exotic forest trees in India*, FRI Publication, Dehradun.
- Jha, L.K. and Sen-Sarma, P.K. (1994). *Forest entomology*, Ashish Publishing House, New Delhi.
- Ravindranath, N.H. (2004).*Joint forest management in India*. Oxford University Press.
- Waring, R.H. and Schlesinger, W.H. (1985). *Forest ecosystems: concepts and management*. Academic Press, New York.

**List of practicals:**

01. Determination of temperature, flow rate, discharge rate in a lotic ecosystem.
02. Analysis of free CO<sub>2</sub> in water.
03. Determination of total alkalinity in water.
04. Estimation of dissolved oxygen in water by Winkler's method.
05. Estimation of calcium and magnesium concentration in water/estimation of hardness in water.
06. Estimation of primary productivity in freshwater systems by light and dark bottle method.
07. Analysis of phytoplankton communities in lotic and lentic ecosystem.
08. Study of periphyton communities in lotic ecosystem.
09. Macrophyte community composition in Freshwater.
10. Study of zooplankton community in Freshwater.
11. Study of pleuston and neuston communities in freshwater systems.
12. Study of benthic communities in freshwater system.
13. Estimation of sodium and potassium in water.
14. Estimation of nitrate content of water.
15. Estimation of phosphate content of water.

**Essential readings:**

- APHA (1998) .*Standard methods for the examination of water and wastewater*. American Public Health Association, Washington.
- Edmondson, W.T. (1992).*Freshwater biology*. International Books.
- Fassett, N.C. (2000). *A manual of aquatic plants*. Agrobios.
- Wetzel, R.G. and Likens, G.E. (1979). *Limnological analysis*. WB Saunders Company, Philadelphia.

**List of practicals:**

1. Study of some ethnobotanically important plants.
2. Submission of ethnobotanical field reports.
3. Preparation and submission of ethnobotanical herbarium.
4. Animal diversity in a given area.
5. To analyse the forest cover of North East India based on the Forest Survey of India Report.
6. To study the microenvironment in a forest stand.
7. To study the phenology and leafing pattern of trees .
8. To determine the biomass and NPP of tree species by dimension analysis method.
9. To calculate the dry matter turnover rate and turnover time of different plant components by using provided data.
10. To determine the density and basal area of trees in a forest stand.
11. To determine the litter accumulation in a forest stand.
12. To determine girth increment of forest trees.
13. To study the clump characteristics of bamboos.
14. Study of pests of timber yielding plants.

**Essential readings:**

- Brewer, R. and McCann, M.T. (1982). *Laboratory and field manual of ecology*. Saunders College Publishing.
- FSI (2009) .*State of Forest report (2009)*. Forest Survey of India, Dehradun.
- Jha, L.K. and SenSharma, P.K. (1994). *Forest entomology*. Ashish Publishing House, New Delhi.
- Misra, R. (1968). *Ecology work book*. Oxford and IBH Publishing Co. Calcutta.
- Moore, P.D. and Chapman, S.B. (1986). *Methods in plant ecology*. Blackwell Scientific Publications.
- Mueller-Dombois, D. and Ellenberg, H. (1974). *Aims and methods of vegetation ecology*. John Wiley and Sons, New York.
- Rao, R.R. and Sharma, B.D. (1990). *A manual of herbarium collection*. Botanical Survey of India Publication, Calcutta.

**ECG – 301**  
**BEHAVIOURAL AND WILDLIFE ECOLOGY**

Lectures 45

Credit 5

Marks 100

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- Unit I** History and concept of ethology: Proximate and ultimate analysis of behaviour; innate and learned behaviour; stimuli, communication and signal; territoriality and home range.
- Unit II** Ecology, natural selection and behaviour; social organisation in invertebrates and vertebrates; learning and memory; optimal foraging and optimization theory.
- Unit III** Evolutionary stable strategy (ESS) and game theory; evolution of unsocial behaviour; altruism; Kin selection and reciprocity; adaptive decision making; parental care in animals.
- Unit IV** Basic principles of wildlife management, wildlife values, problems in wildlife protection ;economic and ecological issues; flagship species and their conservation with special reference to tiger, elephant, rhinoceros and hoolock gibbon; wildlife distribution in diverse ecological habitats in India, endangered and threatened species of wildlife in N E India; sanctuaries, national parks and biosphere reserves of India; reserve forests of Assam; wildlife tourism.
- Unit V** Basic concept of radio and satellite telemetry in monitoring wild animals; wildlife conservation education; red data book, WWF, WCU, CITES, TRAFFIC, wildlife (Protection) Act, 1972 (up to last amendment), recognition and classification of zoos, central zoo authority, IUCN Red list categories; wildlife diseases and their management; brief introduction to biodiversity heritage sites, ecological sensitive zone and community conserved area, important bird areas in India.

**Essential readings:.**

- Alcock, J.(2005). *Animal behavior: an evolutionary approach* (8<sup>th</sup> edition). Sinauer Associates, Inc.
- Atkins, M.D.(1980). Introduction to insect behaviour. McMillan Publishing Company.
- BNHS (2004). *The wildlife of India*. Bombay Natural History Society.
- Chapman, M. J. and Reiss, J.L. (1999). *Ecology: principles and applications*. Cambridge University Press.
- Krebs, J. R. and Davis, N. B. (1991). *An introduction to behavioural ecology*. Blackwell Scientific Publications.
- Manning, A. and Dawkins, M. S. (1997). *An introduction to animal behaviour*. Cambridge University Press.
- Mukherjee, A. K. (1982). *Endangered animals of India*. Zoological Survey of India, Kolkata.
- Negi, S.S. (2002). *Handbook of national parks, wildlife sanctuaries and biosphere reserves in India*. Eastern Book Corporation, New Delhi.
- Prater, S. H. (1971). *The book of Indian animals*. Bombay Natural History Society, Mumbai.
- Saharia, V. B. (1990). *Wildlife in India*. Natraj publishers, Dehradun.
- Tikadar, B. K. (1983). *Threatened animals of India*. Zoological Survey of India publication. Kolkata.

### **Additional readings:**

- Anonymous (2004). *The Wildlife (Protection) Act, 1972 (As amended up to 2004)*. Natraj Publishers, Dehradun.
- Chapman, M. J. and Reiss, J.L. (1999). *Ecology: principles and applications*. Cambridge University Press.
- Chetry, D., Chetry, R. and Bhattacharjee, P. C. (2007) .*Hoolock: the ape of India*. A Publication of Gibbon Conservation Centre, Moriani, Jorhat, Assam.
- Choudhury, A. (2000). *The birds of Assam*. WWF – India, N. E. regional office, Gibbon Books.
- Dawkins, R. (1976). *The selfish gene*. New York City: Oxford University Press.
- Gadagkar, R. (2001). *Survival strategies- cooperation and conflict in animal societies*. Harvard University Press.
- Gadagkar, R. (2001). *The social biology of Ropalidia*. Harvard University Press.
- Seshadri, B. (1988). *Call of the wild survival in the sun*. Sterling Publishers Pvt Ltd.

- Unit I** Air pollution: Natural and anthropogenic sources of air pollution; primary and secondary pollutants; pollution from SO<sub>2</sub>, NO<sub>x</sub>, SPM, CO<sub>2</sub>, climate change and ecological response; green house gases and global warming; ozone layer depletion; acid rain; monitoring and control of air pollution; impact of pollutants on ecosystems and human health; biopollutants, (pollen and microflora) of atmosphere and human health.
- Unit II** Water pollution: Types, sources, and effects of water pollution; eutrophication; oil pollution; thermal pollution; waste water treatment; water quality standards; impact of water pollutants on health.
- Unit III** Land and soil pollution: Land degradation due to deforestation, wastelands and their management; coal mining and its environmental impact and restoration; salt affected soils; methane and NO flux in soil; fertilisers and soil pollution; pesticide pollutant of soil; pesticides, environment and human health.
- Unit IV** Other agencies: Noise pollution; effect of noise on health nuclear wastes; ionising radiation and radioactive pollution; solid wastes; E-waste disposal and recycling of solid and hazardous wastes; occupational health hazards.
- Unit V** Management and legislation: Environmental impact analysis & EMP; procedure for reviewing EI analysis and state environmental legislation; air (prevention and control of pollution) Act, 1981; water (prevention and control of pollution) Act, 1974; the environmental (protection) Act, 1986 and rules 1985; scheme of labelling of environment friendly products (Ecomark); ISO certification.

**Essential readings:**

- Agarwal, S.K. (1991) .*Pollution ecology*. Himanshu Publication, Udaipur.
- Blumenthal, D. S. (1995). *Intronduction to environmental health*. Springer Publishing Co. Ltd. New York.
- Bridgman, H. (1990) .*Global air pollution*. John Wiley and Sons.
- Bhattacharjee, K., Mazumder. M.R. and Gupta Bhattacharjee S. (2006). *A text book of palynology (Basic & applied)*. New central book agency (P) Ltd. Kolkata, India.
- Chitkara, M.G. (1998) *Encyclopaedia of Ecology, Environment and pollution* . APH Publishing Corporation.
- Dutta, N.M., Bhattacharjee, S;Mandal, S.and Bhattacharjee, K. (1998). *Current concepts in pollen-spore and biopollutant research*. Research Periodicals and Book Publishing House, New Delhi.
- Freedman B. (1995). *Environmental ecology—the ecological effects of pollution, disturbance and other stresses*. Academic Press,New York.
- Sharma, B.K. and Kaur, H. (1994).*Thermal and radioactive pollution*. Krishna Prakashan Mandir.

### **Additional readings:**

- Abbasi, S. A. (1999). *Environmental pollution and its control*. Cogent international.
- Adams, M. S. and McManus, F. (1994). *Noise and noise law-a practical approach*. Wiley Chancery Law.
- Gary, N. Vandloon and Duffy, S.J. (2000) *Environmental chemistry- a global perspective*. Oxford University Press.
- Jain, A.K. (1998) *Environment and aerobiology*. Research periodicals and book publishing house.
- Sehgal J. and I.P. Abrol (1994) *Soil degradation in India*. National Bureau of Soil Survey and Land Use Planning, Nagpur.
- Santra, S. C. (2001). *Environmental science*. New Central Book Agency.
- Satake, M.; Mido, Y.; Yasuhisa, Y.; Tagudi, S.; Sethi, M. and Iqbal, S.A. (1997). *Environmental toxicology*. Discovery Publishing House, New Delhi.
- Trivedy, R.K. *Pollution and biomonitoring of Indian rivers*, ABD Publishers, Jaipur.
- Trivedy, R. K. (1995). *Encyclopedia of environmental pollution and control, (2 vols.)*. Environ Media Karad, India.



- Unit I** Important national policies: National environmental policy, 2006; national forest policy-1894,1952,and 1988; national water policy 2002 and other policies e.g. national biotechnology policy, national agricultural policy etc .
- Unit II** Legislation: The wildlife protection act 1972 with amendment; the Indian forest act,1927; biodiversity act,2002; environment protection act,1986; the insecticides act with amendments; human rights and international legislation.
- Unit III** Environmental education: Goals and objectives of environmental education; components of environmental education; environmental education in India; value education; objectives, environmental values, valuing nature and cultures.
- Unit IV** Environment awareness and action: Role of NGOs in environmental awareness; environmental movements in India- silent valley movement, chipko movement, narmada bachao andolan; environmental movements in the west- greenpeace, sierra club etc.; international efforts and government action.
- Unit V** Environmental ethics: Definition, history, scope and basic concepts; anthropocentrism, biocentrism and ecocentrism; deep ecology; ecofeminism; ecocentrism in indigenous societies and culture; ethics of pollution by xenobiotics; ethics of global climate change; ethics of pesticide use.

**Essential readings:**

- Anonymous (1997). *The Indian forest act, 1927 along with forest conservation act, 1980*. Natraj Publisher's Dehradun.
- Guha, R. (1989). *The Unquiet woods*. Oxford University Press.
- Guha, R. (Ed.). (1994). *Social ecology*. Oxford University Press
- Martell, L. (1994). *Ecology and society: an introduction*. Polity press, Cambridge, U.K.
- Hayward, I.M. (1995). *Ecological thought:an introduction*. Polity press, Cambridge.

**Additional readings:**

- Bharucha,E. (2005). *Text book of environmental studies*. University Press,Hyderabad.
- Merchant, C. (Eds). (1994). *Ecology (Key concepts in critical theory)*. Rawat Publications, Jaipur.
- Sharma, P.D. (1996). *Ecology and environment*. Rastogi Publication.
- Tiwari,M;K.Khulbe and Tiwari A. (2007). *Environmental studies*.I.K.International,New Delhi.

- Unit I** Nature, scope and significance of soil ecology; Soil formation and development; physical properties of soil (soil colour, texture, bulk density and porosity, soil water, soil air, soil temperature etc.); Soil profile; Soil pH; Soil nutrients and their availability; earthworm activity and vermicompost; green manuring; organic farming; fertilisers and integrated nutrient management.
- Unit II** The soil ecosystem: Development of the soil ecosystem, soil microorganisms and plants (rhizosphere, mycorrhizae, rhizobium and root nodules); microbiological process of nutrient cycling; decomposition of organic material (litter decomposition) by soil microorganisms and soil fauna; biological nitrogen fixation; production of biofertilisers, pesticides by microorganisms and plants.
- Unit III** Ecology of microorganisms: diversity of microorganisms in the ecosystem; soil organisms and ecosystem; habitat relations, isolation of groups of microorganisms (from soil, rhizosphere, phyllosphere), microbial interactions (i.e., antibiosis, fungistasis, exploitation and lysis); microorganisms as pathogens; biological and chemical control plant pathogens.
- Unit IV** Concept of agroecosystem: Agroecological zones of India; agricultural systems of the world; agricultural systems of north- east India, shifting cultivation system; agroforestry system; rice farming system; tea agroecosystem (soil and climate, shade, weed, nutrition; water management; integrated pest management (IPM) in tea agroecosystem; green revolution: impact of modern agriculture on environment; major agricultural issues related to India.
- Unit V** Significance and ecological perspectives of major groups of agricultural pests; nature of damage, eco-biology, economic status of major groups of pests; concept of IPM; various mechanisms of IPM and their ecological consequences.

**Essential readings:**

- Atlas, R.M. and Richard B. (2000). *Microbial ecology*. Wesley Longmann Inc.
- AnanthaKrishnan, T.N. (1996). *Forest litter insect communities biology and chemical ecology*. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
- Baruah, D.N. (1989). *Science and practices in tea culture*. T.R.A., Calcutta.
- Banerjee, B. (1993). *Tea production and processing*. Oxford and IBH Publishing Co. Pvt. Ltd.
- Brady, N.C. (2003). *The nature and properties of soils* (13<sup>th</sup> Edn.), Pearson Education.
- Baker K.F and Cook R.J. 1974 (1979). *Biological control of plant pathogens*. W.H. Freeman and company USA/S. Chand and Company Ltd.
- Coleman, D.C.; Crossley, D.C. and Hendrix, P.F. (2004). *Fundamentals of soil ecology* (2<sup>nd</sup> edition). Elsevier.
- Coyne, M. (1999). *Soil microbiology: an exploratory approach*. Delmar Publishers, New York.
- Chakrabarty, J. (1994). *Field management in tea*. TRA, Tocklai Experimental Station, Jorhat, Assam.
- Cook R.J. and Baker K.F. (1989). *The nature and practice of biological control of plant pathogens*. APS press, The American Phytopathological Society St. Paul. Minnesota

- Dhaliwal, G.S. and Kler, D.S. (1995). *Principles of agricultural ecology*. Himalaya Publishing House.
- Fenemere, P.G. and Prakash, A. (2006). *Applied entomology*. New Age International.
- Ghosh, M.R. (1995). *Concepts of insect control*. New age international limited, New Delhi.
- Griffin, D.M. (1971). *Ecology of soil fungi*. Chapman and Hall, U.K.
- Mehrotra R.S. and Agarwal.A.(2003). *Plant pathology* (2<sup>nd</sup> edition) Tata McGraw Hill, New Delhi.
- Nayar, K.K., Ananthakrishnan, T.N. and David, D.V. (1985). *A text book on general and applied entomology*. Tata McGraw-Hill Publishing Co. Ltd. New Delhi.
- SubbaRao ,N.S.(2000). *Soil microbiology* (4<sup>th</sup> edition). Oxford and IBH Publishing Co.Pvt.Ltd.,New Delhi.
- S.C. Bhandari and Somani L. L. (1994). *Ecology and biology of soil organism*. Agrotech Publishing Academy.
- Trivedi, P.C. (eds).( 2003). *Advances in microbiology*. Scientific Publishers, Jodhpur.

### **Additional readings:**

- Hussain, M. (1996) *Systematic agricultural geography*. Rawat Publications, Jaipur
- ICAR (2009). *Handbook of agriculture*. Indian Council of Agricultural Research.
- ISSS (2009) *Fundamentals of soil science* (2<sup>nd</sup> edition).Indian Society of Soil Science, New Delhi.
- Mulk, M.J. and Sharma, V.S.H. (1993). *Tea culture, processing and marketing*. Oxford and IBH Publications.
- Miller, R.W. and Donahue, R.L. (1995). *Soils in our environment*. Prentice hall of India, New Delhi.
- Pradhan, S. (1980). *Insect pests of crops*. National Book Trust, New Delhi.
- Reddy, M.V. (1995). *Soil organisms and litter decomposition in the tropics*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
- Subba Rao, N.S. (1986) *Soil microorganisms and plant growth*. Oxford and IBH Publishing Co. Ltd.
- Smith, S.E. and Read, D.J. (1997). *Mycorrhizal symbiosis*. Academic Press, London.
- Sprent, J.I. *The biology of nitrogen fixing organisms*,.Tata McGraw-Hill book co. (U.K.) Ltd.
- Singer, M. J. and Munns D. N. (1996). *Soil-an introduction* ( 3<sup>rd</sup> edition). Prentice- Hall, Inc. New Jersey.

**List of practicals:**

1. Activity budgeting of bird species.
2. Study of herpetofauna in and around Assam University campus.
3. Estimation of population size by capture-recapture sampling using Lincoln-Peterson and Schnabel methods.
4. Field trip to protected areas (reserve forest, wild life sanctuary).
5. Study of methods of animal diversity measurement.
6. Collection of ethno botanical plants and preparation of herbarium.
7. A study on the microbial diversity (fungal diversity).
8. Phototactic and geotactic movement in insects & annelids.
9. Measurement of eutrophication in a lentic waterbody.
10. Estimation of air quality in a given locality by using indicator lichens.
11. Study of the atmospheric pollen and fungal spores as aeroallergens.
12. Use of high volume sampler for SPM detection/estimation.
13. Monitoring of noise pollution using decibel meter.
14. Field visit to HPC for industrial pollution study.
15. Studies on the foraging behaviour of any invertebrate/ vertebrate animal.
16. Pugmark recording technique.
17. Studies on bird nest and materials used in nest construction in specific cases.
18. To study occupational health hazards among workers (construction site/brick kilns/fabrication units).

**Essential readings:**

- Alkins, M.D. (1980). *Introduction to insect behaviour*, McMillan Publishing Co. Inc.
- Hainsworth, M.D. (1967). *Experiments in animal behaviour*. Macmillan, London.
- Jain, S.K. (1995). *A manual of ethnobotany*. Scientific Publishers.
- Jain, S.K. and Rao, R.R. (1977). *A handbook of field and herbarium methods*. Today and Tomorrow's Printers and Publishers, New Delhi.
- Marten, P. and Bateson, P. (1986). *Measuring behaviour-an introductory guide*. Cambridge university press. New York, Collier Macmillan Publishers.
- Rosenthal, D.B. (1988). *Environmental science activities*. John Wiley and Sons
- Silverman, P. (1978). *Animal behaviour in the laboratory*. Chapman and Hall, London.

**Additional readings:**

- Goel, P.K. (1997) *Water pollution*. New Age International.
- Rosenthal, D.B. (1988). *Environmental science activities*. John Wiley and Sons.

**ECG – 306**  
**Practical on ECG-304**

Credit 2.5    Mark 50

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**List of practicals:**

01. To study the profile of a soil in the field.
02. To determine the colour of soil samples by Munsell-soil colour chart.
03. To determine the bulk density and porosity of soil samples.
04. To determine the texture of soil samples by sieving method.
05. To determine the pH of soil samples by pH meter.
06. To determine the organic carbon content of soil samples.
07. To study the agroecological zones of India from agroecological map (NBSS & LUP).
08. To study the extent of damage to paddy crop.
09. To study the nature and extent of damage to vegetable crops.
10. Isolation of rhizosphere and soil microorganisms.
11. Isolation of phyllosphere microorganisms.
12. Antagonism study among the fungal organisms.
13. Identification of few plant pathogenic microorganisms.
14. Study of mycorrhizal association.
15. Study of root nodule symbiosis.

**Essential readings:**

- Cappucino, J.G. and Natic, S. (2002) .*Microbiology: a laboratory manual* (6<sup>th</sup> edition).  
Pearson Education.
- Johnson, L.F. (1972) *Methods for research on the ecology of soil-borne plant pathogen*.  
Burgess Publishing Co., USA.
- Munsell soil colour charts (1994) Revised Edition Machbeth Division of Kollmorgen  
Instruments Corporation, New York.
- NBSS and LUP (1995). *Agroecological map of India*. National Bureau of Soil Science and  
Land Use Planning, Nagpur.
- Subba Rao, N.S. (1986). *Soil microorganisms and plant growth*. Oxford and IBH Publishing  
Co.Ltd.

- Unit I** Human ecology: Nature of human ecology, natality, mortality, human population growth, age structure; marriage, fertility, population policy and family welfare; ecological consequence of human population explosion.
- Unit II** Ecology of tribes: Definition and distribution of tribes in India and world; land tribes, land alienation, impact of land reforms, land tenure systems in tribal areas with special emphasis on NE India; shifting cultivation, forests and tribal; impact of industrialisation and urbanisation on tribal.
- Unit III** Rural ecology: Rural set up in India, human settlement patterns, village clusters and their characteristics, case studies on traditional resource management, common property resources; traditional water harvesting techniques; sustainable development; role of woman in resource management in villages.
- Unit IV** Urban Ecology: History of urbanisation; morphology and major characteristics of early proto-cities; pre-industrial, early industrial and modern cities; Urbanisation in N.E.India
- Unit V** Ecological aspects of urbanisation : Concept of cities as 'importing' ecosystem – dependence and demand on countryside; population growth trends in cities; human migration; formation and proliferation of slums; urbanisation and social organisation.

**Essential readings:**

- Agarwal, A. and Narain, S (1997). *Dying wisdom*. Centre for Science and Environment, New Delhi.
- Bose, A. (2001). *India's billion plus people*. B.R. Publishing Corporation, Delhi.
- De Blij, H.J. (2006). *Human geography, culture, society and space* (7<sup>th</sup> edition). John Wiley and Sons.
- Desai, A.R. and Pillai, S.D. (1990). *Slums and urbanisation*. Popular Pakistan, Bombay.
- Husain, M. (1994). *Human Geography*. Rawat Publications, New Delhi.
- Jain S.K. (1995). *A manual of ethnobotany*. Scientific Publisher (Jodhpur).
- Pimentel, D. (2002). *Biological invasion*. CRC Press, New York.
- Prakasa Rao, V.L.S. (1983). *Urbanization in India*. Concept Publishing Company.
- Raha, M.K. and Ghosh, A.K. (Ed.) (1998). *Northeast India-the human interface*. Gyan Publishing House.
- Ramakrishnan, P.S. (2001). *Ecology and sustainable development*. National Book Trust.
- Sinha R.K. and Sinha. S. (2001). *Ethnobiology*. Surabhi Publications Jaipur.

**Additional readings:**

- Kormondy, E.J. (1996). *Concepts of ecology* (4<sup>th</sup> edition). Prentice Hall of India Pvt. Ltd.
- Ramakrishnan, P. S. (1993). *Shifting agriculture and sustainable development: an interdisciplinary study from North East India*. Oxford University Press.
- Singh, U.P. and Singh, A.K. *Human ecology and development in India*. APH Publishing Corporation.
- Srivastava, O.S. (1996). *Demography and population studies*. Vikas Publishing House, Pvt. Ltd, New Delhi.

- Unit I** Biotechnology in environment protection: Role, current status; biotechnology derived tools and processes; industrial ecology and biotechnology; environmental friendly routes and products; bioplastics and biosensors for environmental monitoring; green chemistry and clean technology.
- Unit II** Environmental technologies for waste treatment: Use of genetically-engineered organisms in waste water treatment; packaged microorganisms; immobilised cells and enzymes and benefits; bioreactors and its application; solid waste management with vermicompositing; biotechnological application for waste disposal.
- Unit III** Bioenergy and environmental technology: biofuel, methane, hydrogen gas production, fuel alcohol production and role of organisms; hydrocarbon production; biopolymer; SCP and enzyme production and applications.
- Unit IV** Restoration ecology I: Concepts and scope of restoration, rehabilitation and reclamation; restoration of degraded forest ecosystem, ecosystem rehabilitation of the rural landscape; carbon forestry and eco restoration; ethical dimension of ecological restoration.
- Unit V** Restoration Ecology II: Bioremediation of soils contaminated with hydrocarbons, heavy metals and pesticide etc. and role of microorganisms; restoration of mining habitats and revegetation in toxic waste site; restoration of brick-kiln industry, damaged land; wetland habitat restoration and strategies; wildlife habitat restoration of past excessive resource use.

**Essential readings:**

- Abbasi, S.A. and E. Ramasami (1999). *Biotechnological methods of pollution control*. University Press.
- Andel, J.V. and Avanson, J. (Eds.) (2006). *Restoration ecology: the new frontier*. Blackwell Publishing, USA.
- Andel, J.V. and Avanson, J. (2005). *Restoration ecology*. Blackwell.
- Clewell, A.F. and J. Avanson, (2007). *Ecological restoration: principles, values and structure of an emerging profession*. Island Press.
- Comin F.A (Ed.) (2010). *Ecological restoration - a global challenge*. Cambridge University Press.
- Das, M.K. (2008). *Environmental Biotechnology and Biodiversity Conservation*. Daya Publishing House, New Delhi.
- Dubey, R.C. (1998). *A textbook of biotechnology*. S.Chand and Company Ltd. New Delhi.
- Freedman Bill, (1995). *Environmental ecology-the ecological effects of pollution, disturbance and other stresses*. Academic Press, New York.
- Gupta. G. (2004). *Ecorestoration of the degraded hills*. Vedam Book, New Delhi.
- Harrison, R.M. (1992). *Understanding our environment: introduction to environmental chemistry and pollution*. The Royal Society of Chemistry.

- Jogdand, S.N.2006. *Environmental biotechnology*.Himalaya Publishing House.
- Lohar, P.S.(2005). *Biotechnology*. MJP Publishers, Chennai.
- Perrow M.R. and Davy A.J. (Eds) (2002). *Hand book of restoration ecology (Vol. 1and 2.)* Cambridge University Press, Cambridge.

**Additional readings:**

- Dhar, B.B. (2000). *Mining and environment*. APH Publishing, New Delhi.
- Liu, D.H.F. and Liptak, B. G. (2000). *Wastewater treatment*. CRC Press.
- Ramakrishnan, P.S. ; Campbell, J. ; Demierre, L. ;Gyi, A. ;Malhotra, K.C. ;Mehndiratta, S. ; Rai, S.N. and Sashidharan, E.M. (1994). *Ecosystem rehabilitaion of the rural landscape in south and central Asia: an analysis of issues*. UNESCO Regional Office, New Delhi.
- Singh, J.S. (1993). *Restoration of degraded lands: concepts and strategies*. Rastogi Publication.
- Singh, O.P. (2005). *Mining environment: problems and remedies*. Regency Publications.
- Sharma, P.D. (1996). *Ecology and environment*. Rastogi publication.
- Singh, B. D. (1998). *Biotechnology*. Kalyani publishers.
- Soetaert, W. and E.J. Vabdanne (2009). *Biofuels*. John Wiley and Sons.
- Wise, D. L. (Eds).(1997). *Global environmental biotechnology*. Proceedings of the third international symposium on the international society for environmental biotechnology. Kluwer Academic Publishers, London.



**ECG 403 A**  
**MICROBIAL ECOLOGY**  
**(Special Paper)**

**Lectures 45   Credit 5   Marks 100**

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- Unit I**      Microorganisms: The place of microorganisms in nature; prokaryotes and eukaryotes; useful microorganisms; growth and nutrition of microorganisms.
- Unit II**      Microbial community: Classification, structure and organisation; species diversity, dispersal, interspecific relationships, symbiosis, competition, parasitism, plant and animal pathogenic microorganisms; chemical and biological control of plant pathogens, integrated pest management (IPM).
- Unit III**     Microorganisms with reference to C N and P cycles, effect of microorganisms on host plants; isolation of bacteria, actinomycetes, fungi and algae from soil/rhizosphere and phyllosphere, isolation in pure culture; isolation of plant pathogens from soil/diseased material, culture media, selective media for isolation of specific group/general of microorganisms from soil and plant materials.
- Unit IV**     Microbes as polluting agent: Microbiology of air, air borne pollen and spores and human allergic disorders; microbes as food deteriorating agent, wood rotting fungi mushrooms and poisonous fungi; mushroom cultivation; methods of food preservation, mycotoxins (i.e., aflatoxin) and human health.
- Unit V**      Biotechnological aspects of microbial ecology: Management of agricultural soil, solid waste, composting, vermicompositing; microbial interactions with xenobiotic and inorganic pollutants; bioremediation, biofertiliser.

**Essential readings:**

- Atlas, R. M and Bartha, R. (1980). *Microbial ecology: fundamental and applications*. Addison Wesley Publishing Co.
- Alexander, M. (1979). *Advances in microbial ecology*. Plenum Press, New York.
- Baker K.F and Cook R.J. (1979). *Biological control of plant pathogens*. W.H. Freeman and Company USA/S. Chand and Company Ltd.
- Bhattacharjee, K.; Mazumder. M.R., and Gupta Bhattacharjee S. (2006). *A text book of palynology (Basic & applied)*. New Central Book Agency (P) Ltd. Kolkata, India.
- Campbell, R E (1977). *Microbial Ecology*. Blackwell Scientific Publication, Oxford, England.
- Cook R.J.and Baker K.F. (1989). *The nature and practice of biological control of plant pathogens*. APS Press, the American Phytopathological Society St. Paul. Minnesota.
- Coyne M.S. (1999). *Soil microbiology- an exploratory approach*. Delmar Publishers, London.
- Dutta, N ; .Bhattacharjee M., Mandal, S. and Bhattacharjee, K. (1998). *Current concepts in pollen spore and biopollution research*. Research Periodicals and Book Publishing House, New Delhi.
- Griffin, D.M. (1971). *Ecology of soil fungi*. Chapman and Hall. U.K
- Johnson L.F. and Curl A.F. (1972). *Methods for research on the ecology of soil-borne plant pathogens*. Burgess Publishing Company Ltd., London.
- Subba Rao N.S. (1999). *Soil microbiology* (4<sup>th</sup> Edition) .Oxford & IBH Publishing Co.Pvt. Ltd. New Delhi.

**Additional readings:**

- Jain, A.K. (1998). *Environment and aerobiology research* .Periodicals and Book Publishing House.
- Kathleen Hess-Kosa (2001) .*Indoor air quality: sampling methodologies*. Lewis Publishers.
- Louitt, M. and Miles, J.A. R. (1979). *Microbial ecology*. Springer Verlag, Berlin, West Germany.
- Synch, J M and Peole, N. J. (1979). *Microbial ecology: a conceptual approach*. Blackwell Scientific Publication, Oxford.

**ECG - 403 B**  
**ENVIRONMENTAL MONITORING AND MANAGEMENT**  
**(Special Paper)**

**Lectures 45 Credit 5 Marks 100**

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- Unit I** Monitoring of air and water pollution: Biomonitoring of air pollution-plants as biomonitors; biomonitoring of running water pollution-saprobic, diversity and biotic approaches; biomonitoring and bioaccumulation of heavy metals in aquatic ecosystems; bioaccumulation of pesticides in aquatic ecosystems.
- Unit II** Aquatic toxicology: Acute toxicity; sublethal, chronic toxicity; multispecies toxicity tests; microorganisms in toxicity testing: microtox and other approaches.
- Unit III** Emerging areas: Basic concepts of toxicogenomics; toxicity of engineered nanoparticles; endocrine disrupting chemicals and their hazards; risk assessment of electromagnetic radiation.
- Unit IV** Recent developments in environmental management: Organic farming and its ecological significance; solid and biomedical waste management; management of arsenic and fluoride in groundwater; constructed wetlands in wastewater treatment.
- Unit V** Social and ethical issues: Ethical issues in biotechnology; ethical issues in nanotechnology; nanotechnologies for the developing world- problems and prospects; ecological footprint- concept, application and ethical implications.

**Essential readings:**

- Abbasi, S.A., Abbasi, N. and Soni, R. (1998). *Heavy metals in the environment*. Mittal Publications, New Delhi.
- Bitton, G. (1999). *Wastewater microbiology* (2<sup>nd</sup> edition). John Wiley and Sons.
- Huang, P.M. and Iskander, I.K. (2000). *Soils and groundwater pollution and remediation: Asia, Africa, and Oceania*. Lewis Publishers.
- Moore, J.W. (1991). *Inorganic contaminants of surface water: research and monitoring priorities*. Springer-Verlag.
- Newman, M.C. and Clements, W.H. (2008). *Ecotoxicology: a comprehensive treatment*. CRC Press.
- Radhakrishnan, R. (2002). *Biomedical waste management*. Sumit Enterprises, New Delhi.
- Spellerberg, I.F. (1995). *Monitoring ecological change*. Cambridge University Press.
- Sharma, A.K. (2006). *A handbook of organic farming*. Agrobios (India).
- Ten Have, H. (2007). *Nanotechnology: science, ethics and politics*. UNESCO, Paris.
- Wiersma, G.B. (Ed.). (2004). *Environmental monitoring*. CRC Press.

### **Additional readings:**

- Baird, D.J., Maltby, L., Greig-Smith, P.W. and Douben, P.E.T. (Eds.). (1996). *Ecotoxicology: ecological dimensions*. Chapman and Hall.
- De, A K (2006). *Environmental chemistry*. New Age International Pvt. Ltd. Publishers, New Delhi.
- Gautam, A. (Ed.). (1998). *Conservation and management of aquatic resources*. Daya Publishing House, New Delhi.
- Newman, M.C.( 2001). *Fundamentals of ecotoxicology*. Lewis Publishers.
- Sahai, S (Ed.) *Bioresources and biotechnology-policy concerns for the Asian region*. Gene Campaign, New Delhi.
- Srivastava, U.K. and Patel, N.T. (1990). *Pesticides industry in India: issues and constraints in its growth*. Oxford and IBH, New Delhi.
- Shrivastava, P. (2000). *Environmental pollution and its management*. APH Publishing Corporation, New Delhi.

**ECG - 403 C**  
**FOREST AND AGRICULTURAL BIODIVERSITY AND ECOLOGY**  
**(Special Paper)**

**Lectures 45 Credit 5    Marks 100**

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- Unit I**      Forest biodiversity: Concepts and dimensions of forest biodiversity, measures of forest diversity; functional attributes related to forest biodiversity; biodiversity in secondary forests; approaches to forest conservation.
- Unit II**      Invasion ecology: Introduction, ecological impacts of invasive species; remote sensing and GIS applications in forest ecology and conservation; climate change and forest biodiversity; carbon sequestration and forest biodiversity; phenology of forest trees.
- Unit III**      Agroforestry systems, biophysical and social aspects of agroforestry systems; agroforestry and biodiversity conservation with special emphasis on homegardens ;agroforestry and ecosystem services; shifting cultivation and management of fallows; ecoagriculture and wild biodiversity conservation.
- Unit IV**      Agrobiodiversity: Concept, management and conservation of agrobiodiversity, traditional ecological knowledge: concepts and management of biodiversity; local soil knowledge; national action plan for agrobiodiversity; *on- farm* conservation of plant genetic resources for food and agriculture; management of land races; agrobiodiversity hotspots; globally important agriculture heritage systems (GIAHS).
- Unit V**      The convention on biological diversity, India's biological diversity act 2002 and biodiversity rules,2004; India's plant variety protection and farmers' rights act 2002; forest rights act, 2006; national and international programmes on forest and agrobiodiversity conservation; biodiversity information system and peoples biodiversity register.

**Essential readings:**

- Barnes, B.V., Zak, D.R., Denton, S.R. and Spurr, S.H. (1997). *Forest ecology*, (4<sup>th</sup> edition). John Wiley and Sons.
- Buck, L.E. Lassoie, J.P. and Fernandez, E.C.M. (2002). *Agroforestry in sustainable agricultural systems*. CRC Press.
- Gaston, K.J. and Spicer, J.I. (2004). *Biodiversity: an introduction* (2<sup>nd</sup> edition).Wiley and Black.
- Huston, M.A. (1994). *Biological diversity: the coexistence of species in changing landscapes*. Cambridge University Press.
- Julie, L, Martha, H.F. and Michael, M.P. (2007). *Invasion ecology*. Blackwell Publishing.
- Kannaiyan, S. (Ed.) (2009). *Agrobiodiversity hotspots*.Narosa Publishing House Pvt.Ltd.
- Maxted, N.; Ford-Lloyd, B.V. and Hawkes, J.G. (1997). *Plant genetic conservation: the In-situ approach*. Chapman and Hall.
- Ramakrishnan, P.S. (1992). *Shifting agriculture and sustainable development: an interdisciplinary study from North Eastern India*.UNESCO-MAB.Parthenon Press, Paris, Parthenon Publications.

Scherr, S.J. and J.A. McNeely (2007). *Farming with nature: the science and practice of ecoagriculture*. Island Press.

Schroth, G. et al (2004). *Agroforestry and biodiversity conservation in tropical landscapes*. Island Press.

### **Additional readings:**

Heywood, V.H. and Gardner, K. (eds) (1995). *Global biodiversity assessment*. Cambridge University Press.

ICAR (2009). *Handbook of agriculture*. Indian Council of Agricultural Research.

Kumar, B.M. and Nair, P.K.R. (2006). *Tropical homegardens: a time tested example of sustainable agroforestry*. Springer Science.

Perry, D.A., Oven, R. and Hart, S. (2008). *Forest ecosystems*. Hopkins University Press.

Ramakrishnan, P.S. (2008). *Ecology and sustainable development*. National Book Trust.

Ramakrishnan, P.S. (2008). *Cultural cradle of biodiversity*. National Book Trust.

Schulze, E.D. and Mooney, H.A. (1993). *Biodiversity and ecosystem function*. Springer, Berlin.

NBA (2006). *The biological diversity act, 2002 and biological diversity rules, 2004*. National Biodiversity Authority, Chennai.

Newton, A.C. (2007). *Forest ecology and conservation: a handbook of techniques*. Oxford University Press.

Wood, D and Lenne (1999). *Agrobiodiversity: characterisation, utilisation and Management*. CABI.

Vandermeer, J.H. (2011). *The Ecology of agroecosystems*. Jones and Barlett Publishers.

**ECG – 403 D**  
**PEST MANAGEMENT AND ECOTOXICOLOGY**  
**(Special Paper)**

Lectures 45    Credit 5    Marks 100

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- Unit I**            Introduction: Concept of pest control and pest management; classification of insects, ET and EIL; historical highlights of pest/EIL technology; common sampling techniques in insect pest management; ecotoxicology.
- Unit II**            Ecological studies of major groups of insects pests on: Cucurbit and other vegetable crops, cruciferous, paddy and tea; general idea about plant protection equipments.
- Unit III**           Ecobiology of insect pests on fibre, stored grains and other crops, pest biodiversity in various agro-ecosystems; conservation of beneficial predators.
- Unit IV**           Pest management theory, management by various indigenous or traditional methods; documentation of community wise traditional method practices and their ecological consequences; management by bio-pesticides.
- Unit V**            History of pesticide evolution, classification; toxicity indication mark; formulation conventional insecticides for management; LVC and ULC spraying, median lethal dosage, various methods/spraying of pest control mechanism; concept of integrated pest management and practices; ecological consequences of integrated pest management.

**Essential readings:**

- Awasthi, V B (1991). *Introduction to general and applied entomology*. Scientific publishers, Jodhpur.
- Ghosh, M R (1995). *Concepts of insect control*. New Age International Publishers, New Delhi.
- Grist, D.H. and Lever, R.J.A.W. (1978). *Pests of rice*. Longman.
- Gupta, S.K. (1985). *Handbook: plant mites of India*. Zoological Survey of India, Kolkata.
- Johri, J.K. (2009). *Recent advances in biopesticides*. New India Publishing Agency, New Delhi.
- Pedigo, L. (1996). *Entomology and pest management*. Prentice Hall.

**Additional readings :**

- Fenemore, P G and Prakash, A. (2006). *Applied entomology*. New Age International.
- Metcalf, C L and Flint, E P (1988). *Destructive and useful insects: their habits and control*. Tata McGraw Hill Pub. Co. Ltd., New Delhi.
- Nayar, K. ; Ananthkrishnan, K. and David, B. V. (1985). *General and applied entomology*, Tata McGraw Hills Publishing Co. Ltd., New Delhi.
- Pimental, D. (1990). *Handbook of pest management in agriculture* (2<sup>nd</sup> edition). CRC Press.
- Pradhan, S (1992). *Insect pests of crops*. National Book Trust, New Delhi.
- Rose, H. N.; Ross, C. A. and Ross, J. P. (1990). *A text book of entomology*. John Wiley and Sons.

**ECG – 403 E**  
**ALGAL ECOLOGY AND PHYSIOLOGY**  
**(Special Paper)**

**Lectures 45 Credit 5      Marks 100**

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- Unit I**      Algal ecology and distribution: Structure and classification of algae, phylogeny and taxonomy; pigments, food reserves and extracellular products; symbiotic associations-lichens, azolla, bryophyte symbiosis; algae and higher plant associations; cyanobacteria, ecology and distribution of Indian fresh water and marine algae.
- Unit II**      Algal growth and survival: Algae and eutrophication; toxicity and biofouling; high rate algal ponds; algal immobilisation; algal survival under physical and chemical stresses.
- Unit III**      Algal and pollution: Responses of algae to pollutants; uptake and accumulation of xenobiotic substances; algal biomonitors, bioassays and field assessment of pollution.
- Unit IV**      Algal physiology: Nutritional requirements; anoxygenic photosynthesis and respiration; biological oxidation, nitrogen assimilation, nitrogen fixation.
- Unit V**      Algal biotechnology: Algal products and their uses; cultivation of algae; algal products and their application;; genetic manipulation and strain improvement; algae as energy source, biofuels; algal technologies in soil fertility and soil reclamation; algal biofertilisers.

**Essential readings:**

- Awasthi, D.D. (2000). *A hand book of lichens*. Bishen Singh Mahendra Pal Singh.
- Beyers, R. J. And Odum, H. T. (1993). *Ecological microcosms*.
- Carr, N. G. and Whitton, B. A. (1982). *The biology of cyanobacteria*. Blackwell Scientific Publishers.
- Darley, W. M. (1981). *Algal Biology: a physiological approach*. Blackwell scientific publications.
- Fay, P (1983). *The Blue greens*. Edward Arnold.
- Kumar, H D (1985). *Algal cell biology*. Affiliated East-West press.
- Kumar, H.D. (1999). *Introductory phycology*. East West press.
- Soetaert, W. and Vabdanne E. J. (2009). *Biofuels*. John Wiley and Sons.
- Van Den Hoek, C.; Mann, D.G. and Jahns, H.M. (1995). *Algae: an Introduction to phycology*. Cambridge University Press.

**Additional readings:**

- Desikachary, T.V. (1979). *Cyanaophyta*. ICAR, New Delhi.
- Lee, R F (1980). *Phycology*. Cambridge University Press.
- Nash, T.H. (1996). *Lichen biology*. Cambridge University Press.
- Round, F E (1965). *The biology of algae*. Edward V Arnold.
- Round, F E (1981). *The ecology of algae*. Cambridge University Press.
- Somani, L L *et al.* (1990). *Biofertilisers*. Scientific Publishers, Jodhpur.
- Stewart, W D P (1974). *Biochemistry and physiology of algae*, Blackwell.
- Smith, G.W. (1950). *The Freshwater algae of the United States* (2<sup>nd</sup> edition). Tata McGraw-Hills Book Co. Inc., New York
- Trainer, F. R. (1978). *Introductory physiology*. John Wiley and Sons.



**ECG – 403 F**  
**WILDLIFE CONSERVATION ECOLOGY**  
**(Special Paper)**

**Lectures 45   Credit 5   Marks 100**

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- Unit I**      Wildlife habitat and population: Characteristic, composition and distribution of terrestrial ecosystem with reference to grassland and forests ecosystem in N E India; ecological role of wetland as a wildlife habitat; implications of succession in the management of wildlife; habitat fragmentation and loss of wildlife; gap formation and their impact on wildlife, gap dynamics; habitat assessment indices- community dominance index (CDI), canopy area coverage, foliage height diversity (FHD); concept of key stone and umbrella species.
- Unit II**      Wildlife population characteristics: Feeding and social behaviour, social organization in mammals; study of migratory birds and migratory routes of birds with reference to India; birds census techniques, distribution and abundance of amphibian and reptilian fauna of India; conservation issues of herpeto-fauna of India; case studies of some important wildlife in regional (N. E. India) and local (Barak Valley) areas.
- Unit III**      Economic aspects, wildlife census and other issues: Contribution of wildlife to gross national productivity (GNP) and economic importance of wildlife; wildlife tourism; trade on wildlife and wildlife crime; wildlife corridors; developmental activities versus wildlife conservation; man –animal conflicts; wildlife population survey with reference to census techniques of rhino, tiger, elephant.
- Unit IV**      Wildlife conservation ecology: Endangered and threatened plants & animals of N. E. India; conservation needs - breeding and importance of genetics in wildlife conservation; role of zoos and aquariums in conservation of wildlife; ethics of wildlife conservation; project tiger; crocodile breeding project.
- Unit V**      Wildlife management, management planning: Principles and strategies of wildlife management in protected areas (sanctuaries, national park, biosphere reserves etc.); habitat utilization pattern of rhino, hoolock gibbon, tiger, elephant. and management techniques; role of non-governmental organizations (International, national & regional) in wildlife management and conservation; impact of climate change in wildlife.

**Essential readings:**

- Ali, S. and Dilon, R. S. (1983). *Birds of India and Pakistan*. Bombay Natural History Society, Mumbai.
- Das, C. (2007). *A treatise on wildlife conservation in India*. Eastern Book Corporation, New Delhi.
- Jacobson, S.K. (2002). *Conserving wildlife*. Eastern Book Corporation, New Delhi.
- Mukherjee, A. K. (1982). *Endangered animals of India*. Zoological Survey of India, Kolkata.
- Negi, S.S. (2002). *Handbook of national parks, wildlife sanctuaries and biosphere reserves in India*. Eastern Book Corporation, New Delhi.
- Prater, S. H. (1971). *The book of Indian animals*. Bombay Natural History Society. Mumbai.
- Saharia, V. B. (1990) .*Wildlife in India*. Natraj Publishers, Dehradun

- Sukumar, R. (1992) .*The Asian elephant: ecology and management*. Cambridge university Press.
- Anonymous.(2004). *The wildlife protection act, 1972 (as amended up to 2004)*.Natraj publisher, Dehradun.
- Tikadar, B. K. (1983). *Threatened animals of India*. Zoological Survey of India. Kolkata.
- Tiwari, P.C. and Bhagwati, J. (1997). *Wildlife in the Himalayan foothills: conservation and management*. Eastern Book Corporation, New Delhi.

**Additional readings:**

- Ahmed, M. F.;Das, A and Dutta, S. K. (2009). *Amphibians and reptiles of North east India*. Aaranyak Publication, Guwahati, Assam.
- Chetry, D.; Chetry, R. and Bhattacharjee, P. C. (2007). *Hoolock: the ape of India*. A Publication of Gibbon Conservation Centre, Moriani, Jorhat, Assam.
- Dwivedi, A. P. (1993). *Forestry in India*. Surya Publication, Dehradun.
- Grimmett, R.; Inskipp, T. and Inskipp, C. (2002). *Pocket guide to birds of the Indian subcontinent*. Oxford University Press.
- Islam, Zafar-ul. M and Rahmani, Asad, R. (2004). *Important bird areas in India: priority sites for conservation*. BNHS Publication.
- Mallya, A. (2006). *Wildlife tourism and conservation*. Eastern Book Corporation, New Delhi.

**List of practicals:**

1. Isolation of soil and shizosphere mycoflora and their identification.
2. Study of aeromycoflora through.
  - (a). Petriplate exposure method and.
  - (b). 2-stage Anderson sampler method.
3. Isolation of plant pathogenic fungi.
4. Antagonism study.
5. Screening of pesticides in vitro.
6. Identification of pest and disease causing organisms from tea agroecosystem & their control measures.

**Essential readings:**

- Anonymous (1968). *Plant pathologists pocket book*. Commonwealth Mycological Institution Kew, Surrey, England.
- Barnet, R.L. and Hunter, B.B. (1972). *Illustrated genera of fungi imperfecti*. Burgess Publishing Co. Minnesota, USA.
- Bhattacharjee, K.; Mazumder, M.R. and Gupta Bhattacharjee S. (2006). *A text book of palynology (Basic & applied)*. New Central Book Agency (P) Ltd. Kolkata.
- Gilman J.C. (1956). *A manual of soil fungi*. Oxford & IBH publishing co. Calcutta, New Delhi.
- Johnson L.F. (1972). *Methods for research on the ecology of soil borne plant pathogens*. Burgess Publishing Co., Minneapolis.

**ECG – 404 B**  
**(Practical on Special paper)**  
**Environmental monitoring and management**

**Credit 2.5    Marks 50**

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**List of practicals:**

1. Estimation of nitrate/ phosphate/ silicate content of water/wastewater.
2. Estimation of chlorophyll content of freshwater.
3. Monitoring of UV-A intensity/ electromagnetic radiation in the environment.
4. Estimation of biochemical oxygen demand/ oil and grease in water/wastewater.
5. Enumeration of faecal coliforms in drinking water.
6. Estimation of heavy metals in water/wastewater/sediment/ biota.
7. Extension programme-cum-field report on ecological footprint of communities/pesticide and other hazardous chemical use by communities.

\*Experiments to be conducted by students in a given batch will be selected from the above list subject to the availability of instrumentation/other facilities

**Essential readings:**

- Abbasi, S.A.; Abbasi, N. and Soni, R. (1998). *Heavy metals in the environment*. Mittal Publications, New Delhi.
- APHA, (2005). *Standard methods for the examination of water and wastewater* (21<sup>st</sup> edition). American Public Health Association (APHA), AWWA, WPCF, Washington, DC, USA.
- De, A K. (2006). *Environmental chemistry*. New Age International.
- Michael, P. (1984). *Ecological methods for field and laboratory investigations*. Tata McGraw Hill, New Delhi.

**ECG – 404 C**  
**(Practical on Special paper)**  
**Forest and Agricultural Biodiversity and Ecology**

**Credit 2.5    Marks 50**

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**List of practicals:**

1. Land use/ land cover delineation from satellite imagery using visual interpretation technique.
2. Assessment of density of invasive and native species.
3. To study the structural attributes of plant biodiversity in homegarden agroforestry system.
4. To study the phenological pattern of trees
5. Leaf trait assessment of different plant species.
6. Estimation of biomass and productivity of sample plots.

**Essential readings:**

- Husch, B., Beers, T.W. and Kershaw, J.A. (2003). *Forest mensuration*. John Willey and Sons.
- Lillesand, M.; Kiefer, R.W. and Chapman, J.W. (2008). *Remote sensing and image interpretation*. John Wiley and sons.
- Nair, P.K.R. (1993). *An introduction to agroforestry*. Springer.
- Schwartz, M.D. (2003) *Phenology: An integrative environmental science*. Kluwer Academic Publishers.

**ECG – 404 D**  
**(Practical on Special paper)**  
**Pest Management and Ecotoxicology**

**Credit 2.5    Marks 50**

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**List of practicals:**

1. Identification of major orders of insect pests .
2. Studies on the extent of damage of vegetable crops.
3. Studies on the extent of damage on rice.
4. Familiarities of various groups of pesticides.
5. Determination of lethal dose against insect pest by conventional pesticide.
5. Lethal dose determination by bio-pesticide.

**Essential readings:**

Ghosh, M.R. (1995). *Concepts of insect control*. New Age International Publishers, New Delhi.  
Pedigo, L. (1996). *Entomology and pest management*. Prentice Hall.  
Pradhan, S. (1992). *Insect pests of crops*. National Book Trust, New Delhi.

**ECG – 404 E**  
**(Practical on Special Paper)**  
**Algal Ecology and Physiology**

**Credit 2.5    Marks 50**

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**List of practicals:**

1. Estimation of chlorophyll and carotenoid content of algal samples and lichens.
2. Estimation of protein and phycobiliproteins content of algae.
3. Measurement of photosynthesis of algal sample.
4. Preparation of algal culture media (solid and liquid) and algal inoculation.
5. Observation and characterisation of algal symbiont of algae in lichens.
6. Isolation and characterisation of cyanobacterial species from Azolla.

**Essential readings:**

- Abraham. G.; S. Pabbi and D.W.Dhar. (2009). *Bluegreen algae, a practical manual*. Indian Agricultural Research Institute, New Delhi.
- Awasthi, D.D. (2000). *Lichenology in Indian subcontinent*. Bishen Singh and Mahendra Pal Singh Publisher, Derhadun, India.
- Prescott, G.W. (1952). *Algae of western great lakes area*. Ottokoeltz. Science Publisher, West Germany.
- Stein J.R (1973). *Hand book of phycological methods*. Cambridge University press.
- Wetzel R.G. and Likens. G.E. (1979). *Limnological analysis*. W.B. Saunders Company. Philadelphia.

**ECG – 404 F**  
**(Practical on Special Paper)**  
**Wildlife Conservation Ecology**

**Credit 2.5    Marks 50**

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1. Community analysis : Measurement of species diversity; Shannon Winner index, evenness index, community dominance index, canopy area coverage, foliage height diversity
2. Wildlife census techniques:
  - a. Direct method: Line transect, point transect, quadrat method, stratified and random sampling
  - b. Indirect method: Pellet group counting method, Pugmark census & analysis
3. Wildlife behaviour:
  - a. Mammals: Time and activity budgeting, foraging efficiency
  - b. Birds: Nest construction pattern and materials used in nest construction, time and activity budgeting
4. Data analysis using statistical tools: ANOVA, species diversity, 't' test, paired 't' test
5. Identification of important food plant species of: Mammals, birds, herpeto-fauna.
6. Identification of wildlife specimen/body components: skin, bone, horn, scat, pellet, feather, nest etc.
7. Visit to important wildlife habitat and study of wildlife in wilderness (biosphere reserve, national park, sanctuary or reserve forest or similar such places) (Optional).

**Essential readings:**

- Ali, S. and Dilon, R. S. (1983). *Birds of India and Pakistan*. Bombay Natural History Society, Mumbai.
- Grimmett, R.; Inskipp, T. and Inskipp, C. (2002). *Pocket guide to birds of the Indian subcontinent*. Oxford University Press.
- Michael L. Morrison (2009). *Restoring wildlife: ecological concepts and practical applications*. Island Press, USA.



## **ECG-405(A/B/C/D/E/F)**

**Dissertation on special papers 403 (A/B/C/D/E/F)\***

**Credit 7.5**

**Marks 150**

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Each student is assigned a specific project in respective of optional papers. The project work involves primary/secondary data collection, analysis, and submission of dissertation. The project is evaluated by internal and external examiners. The students are required to deliver a seminar on this project and defend it before the examiners.

**\* Special papers:**

**ECG 403 A: Microbial ecology**

**ECG 403 B: Environmental monitoring and management**

**ECG 403 C: Forest and agricultural biodiversity and ecology**

**ECG 403 D: Pest management and ecotoxicology**

**ECG 403 E: Algal ecology and physiology**

**ECG 403 F: Wildlife conservation ecology**