ASSAM UNIVERSITY, SILCHAR

SYLLABUS
FOR

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

ENVIRONMENTAL GEOSCIENCES, STATISTICS AND COMPUTER APPLICATIONS

Department of Ecology and Environmental Science
E.P. Odum School of Environmental Sciences

2015

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)

Semester	Course Number	Course Name	Sessional		End semester		Total	L	T	C
			MM	PM	MM	PM				
I	ECG-101	Ecosystem Analysis	30	12	70	28	100	4	2	6
	ECG-102	Population and Community Ecology	30	12	70	28	100	4	2	6
	ECG-103	Natural Resource Management and Remote Sensing Application	30	12	70	28	100	4	2	6
	ECG-104	Environmental Geoscience, statistics and computer applications	30	12	70	28	100	4	2	6
	ECG-105	Practical on ECG-101 and ECG-102	15	6	35	14	50	--	--	3
	ECG-106	Practical on ECG-104	15	6	35	14	50	--	--	3
		Total	150		350		**500**			**30**
II	ECG-201	Freshwater Ecology	30	12	70	28	100	4	2	6
	ECG-202	Forest Ecology	30	12	70	28	100	4	2	6
	ECG-203	Environmental Policy, Education and Ethics- **Choice based**	30	12	70	28	100	4	2	6
	ECG-204	Climate Change - **Choice based**	30	12	70	28	100	4	2	6
	ECG-205	Practical on ECG-201	15	6	35	14	50	--	--	3
	ECG-206	Practical on ECG-202	15	6	35	14	50	--	--	3
		Total	150		350		**500**			**30**
III	ECG-301	Behavioural and Wildlife Ecology	30	12	70	28	100	4	2	6
	ECG-302	Pollution Ecology and Environmental Impact Analysis	30	12	70	28	100	4	2	6
	ECG-303	Biodiversity Conservation	30	12	70	28	100	4	2	6
	ECG-304	Soil, Microbial and Agricultural Ecology	30	12	70	28	100	4	2	6
	ECG-305	Practical on ECG- 301 and ECG- 302	15	6	35	14	50	--	--	3
	ECG-306	Practical on ECG-303 & ECG- 304	15	6	35	14	50	--	--	3
		Total	150		350		**500**			**30**
IV	ECG-401	Human Ecology and Disaster Management	30	12	70	28	100	4	2	6
	ECG-402	Environmental Biotechnology and Chemistry	30	12	70	28	100	4	2	6
	ECG-403	Special Paper (403A/B/C/D/E/F/G)	30	12	70	28	100	4	2	6
	ECG-404	Project on Special Paper (403A/B/C/D/E/F/G)	60	24	140	56	200	--	--	12
		Total	150		350		**500**			**30**

*__Special Papers__:

Total Credit- **120**
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
ECG 403G: Ethnobotany and Conservation of Medicinal Plants

(MM = Maximum Marks, PM = Pass Marks, L= Lecture, T= Tutorial, C= Credit)

Scheme of Evaluation

(a) Each theory paper shall carry 100 marks of which 30 shall be reserved for internal assessment of sessional work, comprising three tests. End semester examination in each course paper shall have a question carrying 70 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 30 percent, mark is allotted for internal assessment and 70 per cent for end semester examination. End semester practical examinations are evaluated by external and internal examiners.

(c) Each student has to opt for 2 choice based papers of 6 credits each, of which one should be from other department of the University. Students from other departments may opt ECG-203 as choice based paper. Students of Ecology and Environmental Science may also opt for ECG-204 as one of their choice-based papers.

(d) 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 the 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 6 Marks 100

Unit I Ecology: Basic concepts, scope, multidisciplinary nature and relevance; Ecosystem concept, organization and significance; Biosphere concept, organization and significance; Cybernetic nature of ecosystems.

Unit II Factors affecting ecosystem: Major environmental factors (biotic and abiotic) influencing organisms in various ecosystems; Concept of limiting factors; Liebig's 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 productivity; concept, methods of estimation, world patterns of primary productivity and Man's exploitation of primary productivity; Secondary productivity; concept, methods of estimation, world patterns of secondary productivity, and man's exploitation of secondary productivity.

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.

Course Objectives

- To understand basic concepts of ecology.
- To understand the factors affecting ecosystem.
- To understand energy flow and trophic dynamics.
- To grasp concepts of primary and secondary productivity.
- To learn various concepts of evolutionary ecology.

Course Outcomes

- The course will enable the students to gather in-depth knowledge on the basic concepts of ecology at the ecosystem level.
- The student will learn the abiotic and biotic factors that influence ecosystem structure.
- It will clear the concepts of some basic laws in ecology such as Liebig's law and Shelford law of tolerance.
- The student will understand the concepts of food chains and food webs, the important biogeochemical cycles and the transfer of energy from one trophic level to another.
- The course will help to comprehend the importance of primary and secondary productivity and their measurement along with the various factors affecting them.
- The students will learn about natural selection and its ecological significance, mutation, adaptations and other evolutionary processes in ecology.

Essential readings:

Ambasht R. S. and Ambasht, N. K. (2008) *Text Book of Plant Ecology* (15th edn.). 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* (4th edn.). 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 edn.) Suma Publications, Delhi.

Odum, E.P. and Barrett, G.W. (2005*) Fundamentals of Ecology* (5th edn.). Thompson.

Singh, J.S; Singh, S.P. and Gupta S.R. (2014) *Ecology, Environmental Science and Conservation*. S.Chand & Company Pvt.Ltd. New Delhi.

Additional readings:

Brewer, R. (1994) *Principles of Ecology*. Saunders College Publishing, London.

Chiras, D.D. (2012) *Environmental Science* (9th edn.). Jones and Barlett Learning.

Dash, M.C.and Dash, S.P. (2009) *Fundamentals of Ecology* (3rd edn.). Tata McGraw-Hill Publishing Co., New Delhi.

Nobel, B.J. and Wright, R.T. (1995) *Environmental Science.* Prentice Hall.

Santra, S.C. (2005) *Environmental Science* (2nd edn.). Central Book Agency, Calcutta.

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ECG – 102
POPULATION AND COMMUNITY ECOLOGY
Lectures 45 Credit 6 Marks 100

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 population distribution, aggregation and Allee's principle; Isolation; Population interactions: competition (allelopathy), parasitism, predation, herbivory, protocooperation, commensalisms, mutualism.

Unit III Community ecology: Community concept; Individualistic and organismic nature of communities; Qualitative and quantitative characters of community; Ecological niche; Methods of studying vegetation; Species diversity and its measurement.

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.

Course Objectives

- To study the various attribute of the population.
- To learn about the energetics and interactions in a population.
- To study the aspects of community ecology.
- To learn about ecological succession and climax.
- To get an overview on the terrestrial and aquatic communities.

Course Outcomes

- The course will enable the students to understand the basic units viz. population, and community.
- It will provide detailed information about natality, mortality, carrying capacity etc.
- It will help students to understand the patterns of population distribution and the various interactions between the members of the population such as allelopathy, protocooperation etc.
- It will clarify the underlying concepts of an ecological community and its qualitative and quantitative characteristics.
- It will teach the students various modes of sampling vegetation in the field.
- It will discuss in detail the concepts and measurement of species diversity.
- It will help students understand the successional types, trends, and models.
- It will deal with the theories on climax communities, ecotones and ecotypes.
- It will discuss the plant and animal communities occurring in forests, grassland, desert and mangrove ecosystems.

- The student may learn about the composition and characteristics of the high-altitude communities in detail.

Essential readings:

Begon, M.; Harper, J.L. and Townsend, C.R. (2006) *Ecology: Individuals, Populations and Communities.* Blackwell Scientific Publications.

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* (3rd edn.). Tata McGraw-Hill Publishing Co., New Delhi.

Kormondy, E.J. (1996) *Concepts of Ecology* (4th edn.). Prentice Hall of India, New Delhi.

Narwal S.S. and Patrick T. (1994) *Allelopathy in Agriculture and Forestry.* Scientific Publishers, Jodhpur.

Naskar, K. and Manadal, R. (1999) *Ecology and Biodiversity of Indian Mangroves*. Daya Books.

Odum, E.P. and Barrett, G.W. (2005*) Fundamentals of Ecology.* (5th edn.) Thompson.

Putman, R.J. (1993*) Community Ecology*. Chapman and Hall, New York.

Stiling, Peter (2002) *Ecology: Theory and Practice* (4th edn.). Prentice Hall of India.

Silverton, J.W. (1982) *Introduction to Plant Population*. Longman.

Singh, J.S., Singh, S.P. and Gupta, S.R. (2014) *Ecology, Environmental Science and Conservation*. S.C.Chand & Company Pvt. Ltd., New Delhi.

Additional readings:

Inderjit, Dakshini, K.M.M. and Chesler L. Foy (Eds.) (1999) *Principles and Practices in Plant Ecology*: *Allelochemical Interactions*. CRC Press.

Osborne, P.L. (2012) *Tropical Ecosystems and Ecological Concepts* (2nd edn.). Cambridge University Press.

Sharma, P.D. (2011) *Ecology and Environment* (11thedn.). Rastogi Publication, Meerut.

ECG – 103
NATURAL RESOUCE MANAGEMENT AND REMOTE SENSING APPLICATION
Lectures 45 Credit 6 Marks 100

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 and soil conservation.

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.

Essential readings:

Burrough P.A. and Mc.Donnell R. A. (1998) *Principles of Geographical Information Systems.* (2nd edn.) Oxford University Press.

Dasman, R.F. (1983) *Environment Conservation.* John Wiley and Sons, New York.

Gangstad, E.O. (1990) *Natural Resource Management of Water and Land.* Van Nostrand Reinhold, NewYork.

Jensen J. R. (2005) *Introductory Digital Image Processing*: A *Remote Sensing Perspective* (2nd edn.). Prentice Hill Inc.

Joseph G (2005) *Fundamentals of Remote Sensing* (2nd edn.). University Press.

Lillesand T. M.; Kiefer R. W. and Chipman J.W. (2004) *Remote Sensing and Image Interpretation.* (5th edn.)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.

Rathore, N.S., Mathur, A.N. and Kothari, S. (2007) *Alternate Sources of Energy*. ICAR, New Delhi.

Schlager, N. and J. Weisblatt (2006) *Alternative Energy* (vol. 1, 2 and 3). Thomson and Gale.

Sehgal J. and Abrol, I.P. (1994) *Soil Degradation in India*. Oxford and IBH Publishing Company, New Delhi.

Additional readings:

Pawar. S.H. and Ekal, L.A (2003) *Advances in Renewable Energy Technologies*. Narosa Publishing House Pvt.Ltd., New Delhi.

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 Applications.* Narosa Publishing House Pvt.Ltd., New Delhi.

ECG – 104

ENVIRONMENTAL GEOSCIENCES, STATISTICS AND COMPUTER APPLICATIONS

Lectures 45 Credit 6 Marks 100

Unit I Environmental Geo processes: Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Scale of meteorology, pressure, temperature, precipitation, humidity radiation and wind. Atmospheric stability, inversions and mixing heights, windroses.

Unit II Earth systems and Environmental Geochemistry: Conservation of matter in various geospheres-lithosphere, hydrosphere, atmosphere and biosphere; Earth's processes: concept of residence, time and rates of natural cycles; concept and classification major, trace and rare earth elements; trace elements and health.

Unit III Application of Statistics in Ecology and Environmental Science: Concept of Statistical population, sample and sampling unit, measures of central tendency, standard deviation, variance, coefficient of variance, standard error, normal distribution: definition and statement of properties, parametric and non-parametric tests, test of hypothesis, statistical significance, type I and type II error.

Unit IV Computer Algorithms and Data Analysis: Introduction to ICT, Internet Basics, Introduction to Computing; Computer Algorithms- Role of Algorithms in Computing, Problem Description, Algorithm Design, Elementary Data Structures; Introduction to Data Analysis- Acquisition & Interpretation of Data, Graphical Representation of Data, Data Mapping, Finding Data Patterns, Statistical Methods, Data Analysis using SPSS.

Unit V System Design and DBMS: Introduction to Systems- Systems Analysis and Design, SDLC Phases, working with MATLAB; Introduction to Database Management System- Advantages, Data Models, DBMS Languages; Basics of PHP- Environment Setup, Creating Database, Table, Form design using PHP, Data Connectivity.

Course Objectives:

- To acquire basic knowledge about Environmental Geosciences.
- To understand basic concepts Statistics and about application of Statistics in Ecology and Environmental science.
- To acquire basic computer knowledge and its application in Ecology & Environmental Science .

Course Outcome:

- At the end of the course the students should able to apply the Statistics to solve the Ecological problems and also in environmental aspects.
- Students can apply Computer Knowledge in the field of Ecology and Environmental Sciences. They also knowledgeable and acquainted with Environmental Geosciences.

Suggested readings:

Bernstein I.H and Rowe N.A. (2001) Statistical Data Analysis using Your Personal Computer. Sage Publications

Bhattacharjee, D. and Bhattacharjee D. (2010) *B.Sc Statistics* Vol. I and Vol. II Kalyani Publishers, Ludhiana, India.

Cochran, W.G. (2007) Sampling techniques (3rd edition) Wiley.

Cormen, T.H., Leiserson C.E., Rivest R., and Stein C. (2009) Introduction to Algorithms. PHI Elmasri R. and Navathe S.B. (2017) Fundamentals of Database Systems. Pearson Education. Goon, A.M., Gupta, M.K. and Dasgupta, B. (1996) *Basic Statistics* vol. I and II, The World.

Gupta, S.C. and Kapok, V.K. (2014) *Fundamentals of Mathematical Statistics*. Sultan Chand & Sons. Gupta, S.P. (2014) *Statistical Methods.* Sultan Chand & Sons, New Delhi.

Keller, E.A. (2017) *Introduction to Environmental Geology* (5th edition). Pearson Education, India.

Pagano, G. (2017) *Rare Earth Elements in Human and Environmental Health*.Pan Stanford Publishing Pte.Ltd.

Parker, R.E. (1979) *Introductory Statistics for Biology.* Edward Arnold, London.
Press Pvt. Ltd.

Rajaraman V. (2011) Analysis and Design of Information Systems. PHI.
Snedecor, G.W. (2014) *Statistical Methods.* Wiley, India.

Ullman L. (2014) PHP and MySQL for Dynamic Web Sites, Kindle Edition, Pitchpit Press. Zar, J.H. (2014) Biostatistical Analysis (5th edition). Pearson Education, India.

ECG – 105
Practical on ECG-101 & ECG-102

Credit 3 Marks 50

List of practicals:

1. Determination of abiotic factors in terrestrial ecosystems.
2. Ground mapping with prismatic compass.
3. Estimation of net primary productivity (NPP) of a grassland community.
4. Estimation of population size by quadrat method.
5. Observations on the allelopathic interactions among plants.
6. Estimation of quantitative parameters in a plant community.
7. Estimation of patterns of distribution of species in a community.
8. Estimation of canopy cover using spherical densiometer.
9. Study of primary and secondary consumers of fresh water ecosystems.
10. Studies of lichen community in different habitats.
11. To study Avian diversity by Line Transect method: encounter rate; species richness by Mckinnon's method.
12. Determination of index of association.

Course Objectives:

- To expose the students to the diverse environmental conditions and appreciate the effects and interactions in field conditions.
- To help the students acquire field-based skills and techniques in collection of quantitative and qualitative ecological information.
- To help the students in learning about the different habits and life forms of plants and their ecological importance.
- To help the students in the use of different indices, tools and techniques for the collection of proper and systematic scientific data.
- To help students learn about the life forms at different trophic levels and their ecological role.

Course Outcomes:

- Develop a proper understanding of the different environmental factors that affects the terrestrial and aquatic ecosystems.
- Develop an understanding about the negative and positive plant interactions.
- Understand the different ecological approaches and methods used to assess the plant, animal and microorganism status, distributions, productivity and interactions over diverse habitat types.

Essential readings:

Awasthi, D.D. (2000) *Lichenology in Indian Subcontinent*. Bishen Singh Mahindra Pal Singh, Dehradun.

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 Workbook* (Reprint edn. 2012). Scientific Publishers, Jodhpur.

Mueller-Dombois, D. and Ellenberg, H. (1974) *Aims and Methods of Vegetation Ecology*. John Wiley and Sons, New York.

ECG – 106
Practical on ECG-104

Credit 3 Marks 50

List of practicals:

1. Graphical representations of data through scattergram, bar diagrams, stack-bar diagrams, pie diagrams.
2. Calculation ofrelationship between two samples through product moment correlation, spearman rank correlation and linear regression.
3. Finding differences between two samples through independent and dependent t-test, Mann-Whitney U test.
4. Measuring association through chi-square test.
5. F-test for significant differences between sample variances.
6. Finding differences of mean among samples by ANOVA.
7. Analyse standard rainfall data using SPSS.
8. Analyse data in plant ecology, vegetation ecology etc using SPSS.
9. Calculation of API, PSI, SPM, pH, COD, BOD etc. using MATLAB.
10. Design a webpage and connect a database to store and retrieve data using PHP-MySQL.
11. Design user panel for data submission and admin panel for data validation using PHP-MySQL.

Course Objectives:

- To help students understand the process of developing study design, data arrangement and data processing.
- To help student graphically represent the analysis of field data collected through various types of bar diagrams, pie diagram, frequency distribution through histogram, polygon etc.
- To help students interpret their data through different statistical approaches as tests of significance, correlation, F-test, T-test and ANOVA.
- To help the students learn basic computer applications and understand the know-how of computational ecology.
- To help students understand and work proficiently in MS-Word, MS-Power Point, MS-Access to represent their data efficiently.
- To help students understand and use MS-Excel based statistical tool kits for analysis.

Course Outcomes:

- Understand different statistical tools and ecological applications for drawing better inference of the data collected.
- Understand the different statistical tests of significance, correlation and regression.
- Acquire the basic knowledge pertaining to computer applications and different operating systems in use.
- Familiarize themselves with MS-Word, spreadsheet of worksheet, MS-Power point, MS-Access and analysis and interpretation of ecological data through the use of Microsoft Excel.

ECG – 201

FRESHWATER ECOLOGY

Lectures 45 Credit 6 Marks 100

Unit I Lentic ecosystem: Types and distribution, formation and classification of lakes; Zonation pattern and thermal stratification in lakes; Ecology of artificial reservoirs; Ecology of major lakes of India, lake ecosystem services and management.

Unit II Wetlands: Definition, classification and values of wetlands; Important wetlands of Assam: Ecology, biodiversity and conservation; Convention on wetlands of international importance (Ramsar Convention); National programmes in wetland conservation.

Unit III Lotic ecosystem: Types, zonation and classification; Ecology of major rivers of India; Ecology of temporary streams; Watershed, nutrient spiralling and river continuum concept; Ecology of hyporheic zone.

Unit IV Ecological processes: Environmental factors operative in freshwater ecosystems; Nutrient processing; Nutrient cycling; Productivity of freshwater ecosystems.

Unit V Ecology and conservation of freshwater communities: Phytoplankton, periphyton and macrophytes; Zooplankton, insects and other invertebrates; Fishes and other vertebrates; Aquaculture practices and ecological issues.

Course Objectives:

- Acquiring Knowledge about Lentic, Lotic and other freshwater ecosystems: their characteristics, present status and conservation needs.
- To develop skill in monitoring of freshwater ecosystems: pollution status, and management skills.
- To learn Management techniques and also the present status of managing the condition of the ecosystems.

Course Outcomes:

- The students are expected to have knowledge regarding the Ecology of Freshwater Systems like Lotic system, Lentic system, wetlands and their characteristics, their biodiversity, significance, conservation status etc.
- The students will develop skill in knowing location of various rivers, their ecological features and identification of flow course etc. They will identify various lakes and the ecological features, wetlands and significance of Ramsar site. Significance and importance of Mangroves, their location and why they need to be protected.
- Skill development is also an integral part of the learning process.
- The students will study different case studies and lean to implement the knowledge in solving problems at local and regional level by thorough analysis and applicability.

Essential readings:

Barnes, R.S.K. and Mann, K.H. (1991) *Fundamentals of Aquatic Ecology* (2nd edn.). Blackwell Science.
Closs, G., Downes, B. and Boulton, A. (2004) F*reshwater Ecology*. Blackwell Science Limited, USA.
Hynes, H B N (1970) *The Ecology of Running Waters*, Liverpool University Press.
Hynes, H B N (1960) *The Ecology of Polluted Waters*.LiverpoolUniversity Press.
Odum, E.P. and Barrett, G.W. (2005) *Fundamentals of Ecology* (5th edn.). Thompson.
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* (2nd edn.). McGraw Hills Book Co. Inc., New York.
Williams, D D (1987) *The Ecology of Temporary Waters*. Chapman and Hall, New York.
Wetzel, R.G. (2001) Limnology*; Lake and River Ecosystems* (3rd edn.). Elsevier Science, USA.
National Wetland Atlas: Assam (2010) SAC/RESA/AFEG/NWIA/ATLAS/18/2010, Space Applications Centre (ISRO), Ahmedabad, India.

Additional readings:

Allan, J.D and CastiUo, M.M. (2007) *Stream Ecology: Structure and Functioning of Running Waters* (2nd edn.). Springer Publishers.
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* (2nd edn.). Elsevier.
Jeffries, M. and Mills, D. (1992) *Freshwater Ecology: Principles and Applications*.CBS Publishers.
Lampert, W and Sommer, U. (2007) *Limnoecolgy* (2nd edn.). Oxford University Press.
Whitton, B. A. (1975) *River Ecology*. Blackwell Scientific Publications, Oxford.

ECG – 202
FOREST ECOLOGY
Lectures 45 Credit 6 Marks 100

Unit I Forest and forest environment: Structure of forest ecosystem; Forest microclimate; Forest types of India with special reference to North East India; Forest and Tree cover of India; Sampling designs in forest inventory.

Unit II Ecophysiology of forest trees: Characteristic of tropical trees; Shoot growth and leafing pattern of trees; Growth pattern in bamboo; Phenology of trees; Seed dispersal patterns; Forest seed dormancy and germination; Regeneration ecology of forest trees; seedling functional types; Protocols for tree and bamboo nursery.

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; Forest fire, behaviour and effects.

Unit IV Forest ecosystem management: History of forest management in India; Joint Forest management; Plantation forestry; Application of remote sensing technique in forest management; Deforestation and approaches to forest restoration; Sustainable Forest management.

Unit V Forest laws: Indian Forest Act; Forest Conservation Act; Forest Rights Act; Green India Mission; Social forestry; Urban forestry; Non-timber forest products; Pests of forest trees.

Course Objectives:

- Acquiring Knowledge about Terrestrial ecosystems: their characteristics, present status and conservation needs.
- To develop skill in identifying forest types, monitoring of terrestrial ecosystems, pollution status, and develop management skills.
- To learn Management techniques and the present status of managing the condition of the ecosystems.

Course Outcomes:

- This paper deals with Forest and terrestrial ecology. The students will gather know about different types of forest, their distribution, their biological diversity and conservation.
- Various policies and laws etc will be taught which are essential in application in different environmental issues and problems.
- Skill development, monitoring techniques and analysis of different critical problems will be acquired.

Essential readings:

Barnes, B V; Zak, D R; Denton, S R and Spurr, S R (1998) *Forest Ecology* (4th edn.). John Wiley and Sons.

Champion, H.G. and Seth, S.K. (1968) *A Revised Survey of the Forest Types of India* (Reprinted 2004). Natraj Publishers, Dehradun.

Diwedi, A. P. (1993) *Forestry in India*, Surya Publications, Dehradun.

Evans, J. and Turnbull, J. (2004) *Plantation Forestry in the Tropics* (3rd edn.). Oxford University Press.

FSI (2013) *State of Forest Report 2013*. Forest Survey of India, Dehradun.

Hartmann, H.T., Kester, D.E., Davies, E.T. and Geneve, R.L. (2010) *Hartmann and Kester's Plant Propagation: Principles and Practices*. (8th edn.) Prentice Hall.

Kimmins, J.P. (2004) *Forest Ecology* (2nd edn.). Pearson Education.

Raymond, Y.A. and Ronald G.L. (2003) *Introduction to Forest Ecosystem*: S*cience and Management* (3rd edn.) John Wiley and sons.

Richards, P W (1996) *The Tropical Rain Forest* (2nd edn.). Cambridge University Press.

Roshetko and others (2010) *Tree Nursery Sourcebook - Options in Support of Sustainable Development.* World Agroforestry Centre and Winrock International.

Turner, I.M. (2001) *The Ecology of Trees in the Tropical Rain Forest.* Cambridge University Press.

Whitmore, T.C. (1998) *An Introduction to Tropical Rain Forests* (2nd Edn.). Oxford University Press.

Additional readings:

Anonymous (2004) *The Indian Forest Act, 1927 along with Forest Conservation Act, 1980.* Natraj Publishers, Dehradun.

Banik, R.L. (1995) *A Manual for Vegetative Propagation of Bamboos*. Technical Report No. 6, International Network for Bamboo and Rattan.

Baskin, C.C. and Baskin, J.M. (1998) *Ecology, Biogeography and Evolution of Dormancy and Germination.* Academic Press, San Diego, California.

Chandler, C.C. and others (1991) *Fire in Forestry*. Vol.I and II. Krieger Publishing Company.

Fenner, M. and Thomson, K. (2005) *Seed Ecology*. Cambridge University Press.

Franklin, S.E. (2001) *Remote Sensing for Sustainable Forest Management*. Lewis Publishers.

Husch, B., Beers, T.W. and Kershaw, J.A. (2003) *Forest Mensuration* (4th edn.). John Wiley and Sons, Inc.

Jha, L.K. and Sen-Sarma, P.K. (1994) *Forest Entomology.* Ashish Publishing House, New Delhi.

Liese, W. and Kohl, M. (Eds.) (2015) *Bamboo-The Plant and its Uses.* Springer.

Lele, S. and Menon, A. (Eds.) (2014) *Democratizing Forest Governance in India.* Oxford University Press.

Newton, A. (2007) *Forest Ecology and Conservation.* Oxford University Press.

Ravindranath, N.H. and Sudha, P. (2004) *Joint Forest Management in India*. Universities Press, Hyderabad.

Schwartz, M.D. (Ed.) (2013) *Phenology-An Integrative Environmental Science* (2nd edn.). Springer.

Troup, R.S. (1921) *Silviculture of Indian Trees.* Vol. I-III. Clarendon Press, Oxford.

Tucker, R.P. (2012) *A Forest History of India*. Sage Publications India Pvt.Ltd.

Waring, R.H. and Schlesinger, W.H. (1985) *Forest Ecosystems: Concepts and Management.* Academic Press, New York.

ECG – 203 (Choice-based)
Environmental Policy, Education and Ethics
Lectures 45 Credit 6 Marks 100

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: Environment protection Act,1986; Insecticides Act with amendments and the rules; Human rights and international legislation; The Disaster Management Act, 2005; Land acquisition Act.

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.

Course Objectives:
This paper is choice-based paper for the students of different disciplines of the University other than Ecology and Environmental Science. The aim is to appraise the young minds about the importance of clean and clear environment for the very survival of all the living beings. Hence there is dire need of formulation of policies.

Course Outcomes:
By attending these classes students will be more informed about the issues in environmental policy, valuing nature and cultures, goals of environmental education and environmental ethics.

Essential readings:

Anonymous (1997) *The Indian Forest Act, 1927 along with forest conservation act, 1980*. Natraj Publisher's Dehradun.

Divan, S. and Rosencranz, A. (2002) *Environmental Law and Policy in India* (2nd edn.). Oxford.

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.

Kaushik, A. and Kaushik, C.P. (2014) *Perspectives in Environmental Studies* (4th edn.). New Age International (P) Ltd., New Delhi.

Additional readings:

Bharucha, E. (2013) *Text Book of Environmental Studies* (2nd edn.). Universities Press, Hyderabad.

Merchant, C. (Ed.) (1994) *Ecology* (*Key concepts in critical theory*). Rawat Publications, Jaipur.

Santra, S.C. (2005) *Environmental Science* (2nd edn.*).* Central Book Agency, Calcutta.

Santra, S.C. (2010) *Fundamental of Ecology and Environmental Biology*. New Central Book Agency (P) Ltd. Kolkata

Sharma, P.D. (2011) *Ecology and Environment* (11thedn.). Rastogi Publication, Meerut.

Sulphey, M.M. and Safeer, M.M. (2015) *Introduction to Environment Management* (3rd edn.). PHI Learning Pvt.Ltd, New Delhi.

Tiwari, M., Khulbe, K. and Tiwari A. (2007) *Environmental Studies*.I.K.International, New Delhi.

ECG – 204 (Choice-based)
CLIMATE CHANGE

Lectures 45 Credit 6 Marks 100

Unit I Basic concepts and mechanisms: Climate change, ozone layer depletion, 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; 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 on 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.

Course Objectives:

In the context of global warming and climate change, this choice-based paper is for appraising the students regarding the mechanism of global warming and also the effects of rising temperature in different ecosystems.

Course Outcomes:

This course will provide the students adequate knowledge related to climate change and global warming. Most importantly they will be informed about the mitigation measures like carbon storage and sequestration, carbon management etc. They will also know about the Intergovernmental Panel on Climate Change (IPCC) and its role in mitigation.

Essential readings:

Akimasa S., Kensuke, F., and Hiramatsu, A. (2010) *Adaptation and Mitigation Strategies for Climate Change. Springer.*

Bonan, G. (2008) *Ecological Climatology: Concepts and Applications*. Cambridge University Press.

Burroughs, W.J. (2007) *Climate Change: A Multidisciplinary Approach* (2nd edn.). Cambridge University Press.

Dash, S. K. (2007) *Climate Change*: *An Indian Perspective*. Cambridge University Press India Pvt. Ltd., New Delhi.

IPCC (2007) *Climate Change 2007. Fourth Assessment Report*. Cambridge University Press.

IPCC (2014) *Climate Change 2014. Fifth Assessment Report.* Cambridge University Press.

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:

Bhattacharyya, T., Pal, D.K., Sarkar, D. and Wani, S.P. (Eds.) (2013) *Climate Change and Agriculture.* Studium Press (India) Pvt.Ltd.

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.

Lal, R. and Follett, R.F. (Eds.) (2009) *Soil Carbon Sequestration and the Greenhouse Effect.* Soil Science Society of America.

Paeke, S. and Smith, J. (2009) *Climate Change: From Science to Sustainability* (2nd edn.). Oxford University Press.

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.

Shukla, P.R., Sharma, S.K., Ravindranath, N.H.Garg, A. and Bhattacharyya, S. (2003) *Climate Change and India: Vulnerability Assessment and Adaptation*. Universities Press Pvt.Ltd. Hyderabad.

Wollenberg, E.K., Nihart, A., Tapio-Bistrom, M.L. and Grieg-Gran, M. (2012) *Climate Change Mitigation and Agriculture.* Earthscan, London.

ECG – 205
Practical on ECG-201

Credit 3 Marks 50

List of practicals:

1. Determination of light intensity, temperature, flow rate and discharge rate in freshwater ecosystem.
2. Determination of pH, conductivity and transparency in freshwater ecosystems.
3. Analysis of free CO_2 in water.
4. Determination of total alkalinity in water.
5. Estimation of dissolved oxygen in water by Winkler's method.
6. Estimation of calcium and magnesium concentration in water / estimation of hardness in water.
7. Estimation of sodium and potassium in water.
8. Estimation of nitrate content in water.
9. Estimation of phosphate content in water.
10. Estimation of primary productivity in freshwater systems by light and dark bottle method.
11. Analyses of phytoplankton communities in lotic and lentic ecosystems.
12. Study of periphyton communities in lotic ecosystems.
13. Macrophyte community composition in freshwater ecosystems.
14. Qualitative and quantitative studies of zooplankton community in freshwater systems.
15. Qualitative and quantitative studies of aquatic insect community in freshwater systems.
16. Estimation of biological oxygen demand in water.

Course Objectives:

- To impart knowledge on various methods applied for studying freshwater ecosystems.

Course Outcomes:

- Understand and appreciate the fresh water ecosystems with reference to its various abiotic and biotic components and the various ecological processes which are going on in such systems.
- Appreciate the role of human being in management of freshwater systems for its better functional role and helping the living organisms including human being for their survival in a better way.

Essential readings:

APHA (2012) *Standard Methods for Examination of Water and Wastewater* (22nd edn.). American Public Health Association, Washington.

Edmondson, W.T. (1992) *Freshwater Biology*. International Books and Periodicals Supply Service, New Delhi.

Battish, S.K. (1992) *Fresh Water Zooplankton of India.* Oxford and IBH Publishing Co., New Delhi.

Fassett, N.C. (2000) *A Manual of Aquatic Plants.*Agrobios.

Maiti, S.K. (2011) *Handbook of Methods in Environmental Studies. Vol. I. Water and Waste Water Analysis*. Oxford Book Company, Jaipur.

Wetzel, R.G. and Likens, G.E. (1979) *Limnological Analysis*. WB Saunders Company, Philadelphia.

ECG – 206
Practical on ECG-202

Credit 3 Marks 50

List of practicals:

1. To analyse the forest cover of North East India based on the Forest Survey of India Report.
2. To determine the density and basal area of trees in a forest stand.
3. To study the vertical stratification of a forest.
4. To study the plant population structure in a forest stand.
5. To study the phenology and leafing pattern of trees.
6. To study the reproductive allocation in plants.
7. To determine the litter accumulation in a forest stand.
8. To determine biomass of a forest stand by allometric model.
9. To determine the girth increment of trees in a forest stand.
10. To study the forest invasive species and their distribution pattern.
11. To study the culm and rhizome characteristics of bamboos.
12. To prepare land use/land cover map using visual interpretation technique.
13. To raise the seedling nursery of selected trees.
14. To study the techniques of bamboo propagation for raising bamboo nursery.
15. To study the pests of timber yielding plants.

Course Objectives:

- To impart knowledge on various methods applied for studying forest ecosystems.

Course Outcomes:

- Be more conversant with the various biotic components and the various ecological processes which are going on in forest ecosystem.
- Appreciate the role of forest ecosystem in maintaining a balance in nature and helping the living organisms including human being for their survival in a better way.

Essential readings:

Banik, R.L. (1995) *A Manual for Vegetative Propagation of Bamboos*. Technical Report No. 6, International Network for Bamboo and Rattan.

Bisht, N.S. and Ahlawat, A.S. (1999) *Seed Technology*. Information Bulletin no.7. State Forest Research Institute (SFRI), Arunachal Pradesh.

Singh, U.V., Ahlawat, A.S. and Bisht, N.S (2003) *Nursery Techniques for Local Tree Species*. Information Bulletin no.11. State Forest Research Institute (SFRI), Arunachal Pradesh.

FSI (2013) *State of Forest Report.* Forest Survey of India, Dehradun.

Husch, B., Beers, T.W. and Kershaw, J.A. (2003) *Forest Mensuration* (4th edn.). John Wiley and Sons, Inc.

Jha, L.K. and Sen-Sharma, P.K. (1994*) Forest Entomology*. Ashish Publishing House, New Delhi.

Joseph G (2005) *Fundamentals of Remote Sensing* (2nd edn.). University Press.

Lillesand T. M.; Kiefer R. W. and Chipman J.W. (2004) *Remote Sensing and Image Interpretation* (5th edn.). Wiley India.

Misra, R. (1968) *Ecology Workbook* (Reprint edn. 2012). Scientific Publishers, Jodhpur.

Mueller-Dombois, D. and Ellenberg, H. (1974) *Aims and Methods of Vegetation Ecology.* John Wiley and Sons, New York.

ECG – 301
BEHAVIOURAL AND WILDLIFE ECOLOGY

Lectures 45 Credit 6 Marks 100

Unit I History and concept of ethology: Proximate and ultimate analysis of behaviour; Stimuli, communication and signal; Territoriality and home range; Ecology, natural selection and behaviour

Unit II Social organisation in invertebrates; Social organisation in Vertebrates; Types of Behaviour: innate and learned behaviour; Reasoning 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, flagship species and their conservation with special reference to rhinoceros and hoolock gibbon; Distribution of wildlife in diverse ecological habitats in India, Endangered mammals of India, Threatened wildlife species in N E India; National parks and biosphere reserves of India; Wildlife sanctuaries of N. E. 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; Important bird areas in India.

Course Objectives:

The course is intended to provide basic knowledge related to –

- Concept of ethology (science of animal behavior)
- Social organisation and behaviour patterns in invertebrates and vertebrates
- Evolutionary stable strategy and evolution of unsocial behavior, adaptive decision making and parental care.
- Basic principles and values of wildlife management in diverse ecological habitats in India with special reference to N. E. India, reserve forests of Assam including the prospects of Wildlife tourism.
- Basic concept of radio and satellite telemetry in monitoring wild animals and wildlife conservation education

Course Outcomes:

The students are expected to learn about the following –

- Science of animal behaviour and social organization in invertebrates and vertebrates
- Evolutionary stable strategy and adaptive decision making process
- Different relevant issues pertaining to wildlife management practices with special reference to N. E. India
- Application of modern techniques for monitoring wild animals in relation to wildlife conservation

Essential readings:

Alcock, J. (2005) *Animal Behaviour: An Evolutionary Approach* (8th edn.). SinauerAssociates, 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.

Davis, N. B., Krebs, J. R. and West, S.A. (2012) *An Introduction to Behavioural Ecology* (4th edn.*).* Wiley-Blackwell.

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, 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*. 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.

ECG – 302

POLLUTION ECOLOGY AND ENVIRONMENTAL IMPACT ANALYSIS

Lectures 45 Credit 6 Marks 100

Unit I Air pollution and its effects: Air pollution from primary and secondary pollutants; Ozone chemistry and ozone layer depletion; Acid rain and its impact on ecosystems; Bio-pollutants, bio-allergens of atmosphere and human health.

Unit II Water pollution: Types, sources and effects of water pollution, concept of DO, BOD and COD; Eutrophication, oil pollution and thermal pollution; Waste water treatment and recycling; Water quality standards and impact of water pollutants on health.

Unit III Land and soil pollution: Land degradation types; Status of wastelands in India; Coal mine and it's environmental impact and restoration; Salt affected soils and their management; Acid soil and its management; Land degradation due to brick kiln industry and restoration; Fertilizers and soil pollution; Pesticide pollution of soil; Pesticides, environment and human health.

Unit IV Other agencies: Noise pollution and effect of noise on health; Nuclear wastes; Radionuclides, 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 and 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; Scheme of labelling of environment friendly products (Ecomark); ISO certification.

Course Objectives:

The course is intended to provide basic knowledge related to –

- Air pollution, ozone layer depletion, and the impact on ecosystems; bio-pollutants, bio-allergens and effects on human health.
- Water pollution, wastewater treatment and recycling, water quality standards, eutrophication, oil pollution and thermal pollution; and affect health.
- Land and soil pollution: land degradation types; status of wastelands in India and it's environmental impact and restoration
- Noise pollution, nuclear wastes, radionuclides, solid wastes, e-waste disposal and recycling and related health hazards
- EIA, EMP, pertinent environmental legislation, acts etc.

Course Outcomes:

The students are expected to learn about the following –

- Air pollution, water pollution, soil pollution, impacts on health
- Noise pollution, radioactive nuclide pollution, e-waste disposal
- Environmental impacts, recycling and restoration
- Pertinet environmental legislation

Essential readings

Agarwal, S.K. (1991) *Pollution Ecology*. Himanshu Publication, Udaipur.

Blumenthal, D. S. (1995) *Introduction 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.

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.

Sarkar, A.K. (2013) *Acid Soils-their Chemistry and Management*. New India Publishing Agency (NIPA), New Delhi.

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.

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.

Maiti, S.K. (2012) *Ecorestoration of the Coalmine Degraded Land*. Springer.

Santra, S. C. (2005) *Environmental Science* (2nd edn.). 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. (1995) *Encyclopedia of Environmental Pollution and Control (2 vols*.). Environ Media, Karad, India

Trivedy, R.K. (2000) *Pollution and Biomonitoring of Indian Rivers.* ABD Publishers, Jaipur.

Van Leeuwen, C.J. and Vermeire, T.G. (Eds.) (2007) *Risk Assessment of Chemicals* (2nd edn.). Springer.

ECG – 303
BIODIVERSITY CONSERVATION

Lectures 45 Credit 6 Marks 100

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: ***i****n 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); Millennium 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: Biological diversity act, 2002; National biodiversity strategy and action plan (NBSAP); National Biodiversity Authority (NBA); Threats to biodiversity: Indian context; Community conservation area; Ecological sensitive zone; Island Biogeography: metapopulation concept; Biodiversity hotspots, their characteristic flora and fauna.

Unit IV Biodiversity resources of north-east India: Plant diversity of north-east India; Threatened vascular plant species; Biological invasions; Diversity of Megafauna in north-east India; Important protected areas of north east India; Biodiversity conservation in Barak Valley: problems and prospects.

Unit V Indigenous approaches to biodiversity conservation: Traditional knowledge & significance of study; Sacred Groves (Forests); Ecosystem people and nature; Biodiversity of 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 ethics towards the conservation of medicinal plants; Traditional Knowledge Digital Library (TKDL).

Course Objectives:

- To impart knowledge about the need, basic understandings and the importance of plant and animal biodiversity
- To impart knowledge about the status of biodiversity across global, national and regional level and the importance of their conservation.
- To impart knowledge about the values and importance of traditional knowledge on biodiversity among the tribal mass/ ethnic people and also the matters pertaining to Intellectual Property Right (IPR).

Course Outcomes:

- Learn the basics of biodiversity conservation and apply them to solve the issues and challenges that hinder the conservation of biodiversity.
- Get acquainted with the various initiatives taken at the global and national level to save and conserve biodiversity.
- Have a clear understanding about the plant and animal genetic resources available in and around them and will have motivation to initiate steps for their conservation.

Essential readings:

Cotton, C.M. (1997) *Ethnobotany: Principles and Applications*. John Wiley and Sons, New York.
Huston, M.A. (1995) *Biological Diversity*. Cambridge University Press.
Jain S.K. (1995) *A Manual of Ethnobotany*. Scientific publishers, 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.
Sharma, A.K., Ray, D. and Ghosh, S.N. (2012) *Biological Diversity: Origin, Evolution and Conservation.*Viva Books.
Sinha R.K and Sinha, S. (2001) *Ethnobiology*. Swastik Publications, Jaipur.

Additional readings:

Gaston, K.G. (2004) *Biodiversity: An Introduction* (2nd edn.). Blackwell Science Ltd.
Geethabali, R.R. (2002) *Biodiversity: Monitoring, Management, Conservation and Enhancement.* APH
MacArthur, R.H. and Wilson, E.O. (1967) *The Theory of Island Biogeography*. Princeton University Press, Princeton, NJ.
May, R.M. and McLean, A.R. (Eds.) (2007) *Theoretical Ecology: Principles and Applications.* Oxford University Press.
Pullin, A. S. (2002) *Conservation Biology*. Cambridge University Press.
Ramakrishnan, P.S., Saxena, K.G. and Chandrashekara, U.M. (Eds.) (1998) *Conserving the Sacred for Biodiversity Management.* Oxford and IBH Publishing Company Pvt.Ltd.

ECG – 304
SOIL, MICROBIAL AND AGRICULTURAL ECOLOGY
Lectures 45 Credit 6 Marks 100

Unit I Nature, scope and significance of soil ecology; Soil formation and development; Soil profile; Physical properties of soil (soil colour, texture, bulk density and porosity, soil water, soil air, soil temperature etc.); Soil pH; Soil organic matter; Soil nutrients (macro and micro) and their availability; Fertilisers and integrated nutrient management; Organic farming; Conservation agriculture; Soil quality and soil health.

Unit II Soil as a medium for plant growth: Development of the soil ecosystem, soil microorganisms and plants (rhizosphere, mycorrhizae, rhizobium and root nodules); Decomposition of organic material (litter decomposition) by soil microorganisms and soil fauna; Biological nitrogen fixation; Production of biofertilisers; Pesticides in the environment, degradation of pesticides by microorganisms.

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 of plant pathogens.

Unit IV Concept of agroecosystem: Agroecological zones of India; Agricultural systems of north-east India, shifting cultivation system, rice farming system; Agroforestry system; Tea agroecosystem (soil and climate, shade, weed, nutrition; Water management; Integrated pest management (IPM) in tea agroecosystem; Organic tea; Green revolution: impact of modern agriculture on environment; Major agricultural issues related to India; GM crops.

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.

Course Objectives:

- To impart knowledge about the various aspects of edaphic ecosystem, its formation, microorganisms inhabiting in it and their ecological role.
- To impart knowledge about the various practices used in agro-ecosystem that is essential for sustainable agriculture.
- To impart knowledge about the various types of pesticides that is used in agriculture.
- To have an understanding about the pests in various agriculture and impart knowledge about their control in such a way so that the quality of ambient environment is not compromised.

Course Outcomes:

- Have a detailed idea on the importance of soil conservation.
- Know in detail about the various beneficial and harmful microorganisms present in soil, and to adopt appropriate measures for soil conservation.
- Have a detailed idea about the harmful aspects of use of inorganic pesticides on the ecosystems
- Develop a clear idea on the types of pesticides for use in agricultural sectors.

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. and Weil, R. (2008) *The Nature and Properties of Soils (*14th edn.). Pearson International.

Baker K.F and Cook R.J. (1979) *Biological Control of Plant Pathogens.* W.H. Freeman and company USA/S. Chand and Company Ltd.

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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 Amreican 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 Limited, New Delhi.

Gaur, A.C. (2006) *Biofertiliser in Sustainable Agriculture*. ICAR, New Delhi.

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* (2nd edn.). 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.

Subba Rao, N.S. (2000) *Soil Microbiology* (4th edn.). Oxford and IBH Publishing Co.Pvt.Ltd, New Delhi.

Trivedi, P.C. (Eds.). (2003) *Advances in Microbiology*. Scientific Publishers, Jodhpur.

Additional readings:

Bhandari,S.C. and Somani L. L. (1994) *Ecology and Biology of Soil Organisms*. Agrotech Publishing Academy.

Gaur, A.C. (2006) *Biofertiliser in Sustainable Agriculture*. ICAR, New Delhi.

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

ISSS (2009*) Fundamentals of Soil Science* (*2nd edn.*). Indian Society of Soil Science, New Delhi.

Metting F. Blaine (1992) *Soil Microbial Ecology: Applications in Agricultural and Environmental Management.* CRC Press.

Miller, R.W. and Gardiner, D.T. (2007) *Soils in Our Environment* (11th edn.). Prentice Hall of India, New Delhi.

Mulk, M.J. and Sharma, V.S.H. (1993) *Tea: Culture, Processing and Marketing*. Oxford and IBH Publications.

Paul, E.A. (Ed.) (2006) *Soil Microbiology, Ecology and Biochemistry* (3rd edn.). Academic Press.

Pradhan, S. (1980) *Insect Pests of Crops*. National Book Trust, New Delhi.

Ramakrishnan, P.S., Saxena, K.G., Swift, M.J. Rao, K.S. and Maikhuri, R.K. (2005) *Soil Biodiversity, Ecological Processes and Landscape Management*. Oxford and IBH, 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.

Singer, M. J. and Munns D. N. (1996) *Soil: An Introduction* (3rd edn.). Prentice- Hall, Inc. New Jersey.

ECG – 305
Practical on ECG-301 and ECG – 302
Credit 3 Marks 50

List of practical:

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.
4. Field trip to protected areas (reserve forest, wild life sanctuary etc.).
5. Study of methods of animal diversity measurement.
6. A study on the microbial diversity (fungal diversity).
7. Measurement of eutrophication in a lentic water body.
8. Estimation of air quality in a given locality by using indicator lichens.
9. Study of the atmospheric pollen and fungal spores as aeroallergens.
10. Use of high-volume sampler for SPM detection/estimation.
11. Monitoring of noise pollution using decibel meter.
12. Field visit to HPC for industrial pollution study.
13. Studies on the foraging behaviour of any invertebrate/ vertebrate animal.
14. Pugmark recording technique.
15. Studies on bird nest and materials used in nest construction in specific cases.
16. To study occupational health hazards among workers (construction site/brick kilns/fabrication units).
17. Environmental impact assessment of brick kiln industries.

Course Objectives:

- To impart knowledge about the animal diversity in and around Assam University campus
- To impart knowledge about the population estimation of macro-fauna

Course Outcomes:

- Get acquainted with the various fauna present in the university locality and their population estimation procedure.

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**.**
Marten, P. and Bateson, P. (1986) *Measuring Behaviour-An Introductory Guide*. Cambridge University Press, New York.
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. (2009) *Water Pollution*. New Age International.
Rosenthal, D.B. (1988*) Environmental Science Activities*. John Wiley and Sons.

ECG – 306
Practical on ECG -303 and ECG - 304

Credit 3 Marks 50

List of practical:

1. Identification and description of important plants used by the tribes of N.E. India.
2. Preparation of ethnobotanical herbarium.
3. To study the plant diversity of Assam University campus.
4. Visit to tribal area and study of plant material used by the tribals.
5. Submission of ethnobotanical field reports along with photographic documentation.
6. To study the species diversity of trees in a forest stand.
7. To study Avian diversity by point count method.
8. To determine the colour of soil samples by Munsell soil color chart.
9. To determine the bulk density and porosity of soil.
10. To determine the texture of soil samples.
11. To determine the pH of soil samples using pH meter.
12. To determine the organic carbon content of soil samples.
13. To study the extent of damage to paddy crop.
14. To study the nature and extent of damage to vegetable crops.
15. Isolation of rhizosphere and soil microorganisms.
16. Isolation of phyllosphere microorganisms.
17. Antagonism study among the fungal organisms.
18. Identification of few plants' pathogenic microorganisms.

Course Objectives:

- To impart knowledge about the various aspects of edaphic ecosystem, its formation, microorganisms inhabiting in it and their ecological role.
- To impart knowledge about the estimation methods of different soil physical and chemical properties

Course Outcomes:

- Knowledge about soil health estimation
- Understanding plant pathogen interaction

Essential readings:

Cappuccino, J.G. and Sherman, N. (2013) *Microbiology: A Laboratory Manual* (10th edn.). Benjamin Cummings.

Gupta, I.C., Yaduvanshi, N.P.S., Gupta, S.K. (2012) *Standard Methods for Analysis of Soil, Plant and Water.* Scientific Publishers.

Jain S.K. (1987) *A Manual of Ethnobotany*. Scientific publishers, Jodhpur.

Jain, S.K. and Rao, R.R. (1977) *Hand Book of Field and Herbarium Methods.* Today and Tomorrow's Printer and Publishers, New Delhi.

Johnson, L.F. (1972) *Methods for Research on the Ecology of Soil-Borne Plant Pathogen*. Burgess Publishing Co., USA.

Munsell Soil Color Book (2009) Revised Edition. Macbeth Division of Kollmorgen Instruments Corporation, New York.

Sarkar, D. and Halder, A. (2010) *Physical and Chemical Methods in Soil Analysis* (*2nd edn.*). New Age Publishers.

ECG 401
HUMAN ECOLOGY AND DISASTER MANAGEMENT
Lectures 45 Credit 6 Marks 100

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 villlages.

Unit IV Urban Ecology: History of urbanisation; Theories and models of urban patterns and structures; Urbanisation in India with special reference to NE India; Ecological aspects of urbanisation: Concept of cities as 'importing' ecosystem – dependence and demand on countryside.

Unit V Disaster Management: Major types of disasters: Earthquake, Flood, Tsunami, Nuclear, Chemical disasters, Biological disasters. Disaster Hazard, Risk and Vulnerability Profile of India; Disaster management: Approaches, Policy objectives, cycles, risk assessment and vulnerability mapping; Disaster response: Central, State, District and Local administration; Disaster and health scenario.

Course Objectives:

- To learn meaning of human ecology in the context of ecosystem by the learner and impact of population explosion.
- To learn and have an experience regarding land alienation and land tenure systems in tribal communities.
- To get focus about village ecosystem, rural structure, pattern of urbanization and human race livelihood.
- To get aware regarding disaster management during and post disaster management.

Course Outcomes:

- Learner perform their expertise in ecologically sustainable livelihood pattern in rural and urban areas.
- Aware and guide the rural and urban people regarding impact of population explosion and ecological disbalance.
- Knowledge will help in urban and rural structure policy making affairs.
- Preliminary ideas and experiences of disaster management helps in mitigation during pre and post natural disaster periods.

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.

Carter, W. N. (1991) *Disaster Management*. Asian Development Bank, Manila.

Central Water Commission (1987) *Flood Atlas of India.* CWC, New Delhi.

Central Water Commission (1989) *Manual of Flood Forecasting*. CWC, New Delhi.

Desai, A.R. and Pillai, S.D. (1990) *Slums and Urbanisation*. Popular Pakistan, Bombay.

Edwards, B. (2005) *Natural Hazards.* Cambridge University Press, U.K.

Fouberg, E.H., Murphy, A.B. and De Blij, H.J. (2012) *Human Geography: People, Place and Culture* (10th edn.). Wiley.

BMTPC (2007) *Vulnerability Atlas of India*. Building Materials and Technology Promotion Council, Govt.of India, New Delhi.

Husain, M. (2008) *Human Geography (4th edn.).* Rawat Publications, New Delhi.

Prakasa Rao, V.L.S. (1983) *Urbanization in India*. Concept Publishing Company.

Raha, M.K. and Ghosh, A.K. (Eds.) (1998) *Northeast India-the Human Interface*.Gyan Publishing House.

Ramakrishnan, P.S. (2001). *Ecology and Sustainable Development*. National Book Trust.

Robert L. McConnell and Daniel C. Abel (2013) *Environmental Geology Today*. Jones and Bartlett Learning, India.

Roy, P.S. (2000) *Space Technology for Disaster Management: A Remote Sensing and GIS Perspective.* Indian Institute of Remote Sensing (NRSA), Dehradun.

Sahni, P., *et.al*. (Eds.) (2002) *Disaster Mitigation Experiences and Reflections.* Prentice Hall of India, New Delhi.

Sharma, R.K. and Sharma, G. (Eds.) (2005) *Natural Disaster*. APH Publishing Corporation, New Delhi.

Sinha R.K. and Sinha, S. (2001) *Ethnobiology*. *S*urabhi Publications Jaipur.

Sivaramakrishnan, K.C. Kundu, A. and Singh, B.N. (2007) *A Handbook of Urbanization in India*. Oxford University Press.

www.iirs.nrsa.org

http://quake.usgs.gov

Additional readings:

Kasperson, J.X., R.E. Kasperson, and B.L. Turner III (Eds.) (1995) *Regions at Risk: Comparisons of Threatened Environments*. United Nations University Press, Tokyo.

Kormondy, E.J. (1996) *Concepts of Ecology* (4th edn.). Prentice Hall of India Pvt. Ltd.

NOAA Coastal Services Center, Linking People Information and Technology: Risk and Vulnerability Assessment Tool, at, http://www.csc.noaa.gov/rvat/criticalEdd.html. .

Ramakrishnan, P. S. (1993) *Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North East India.* Oxford University Press.

Singh, S. (2003) *Disaster Management in the Hills.* Concept Publishing Company, New Delhi.

Singh, U.P. and Singh, A.K. (1999) *Human Ecology and Development in India*. APH Publishing Corporation.

Srivastava, O.S. (1996) *Demography and Population Studies*. Vikas Publishing House, Pvt. Ltd, New Delhi.

Taori, K. (2005) *Disaster Management through Panchayati Raj.* Concept Publishing Company, New Delhi.

White, G.F. (1974) *Natural Hazards: Local, National, Global.* Oxford University Press, New York.

White, Gilbert F. and Haas, E.J. (1975) *Assessment of Research on Natural Hazards.* MIT Press, MA.

ECG – 402
ENVIRONMENTAL BIOTECHNOLOGY AND CHEMISTRY
Lectures 45 Credit 6 Marks 100

Unit I Biotechnology in environment protection: Role, current status; Biotechnology derived tools and processes; Industrial ecology and biotechnology; Bioplastics and biosensors for environmental monitoring; Green chemistry and its applications.

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 vermicomposting; 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 Fundamentals of environmental chemistry: Stoichiometry, Gibbs' energy; Chemical potential, Chemical equilibria, Acid base reaction; Solubility product, solubility of gases in water, the carbonate system; Unsaturated and saturated hydrocarbons

Unit V Principles of Analytical methods: Titrimetry, Gravimetry, Colourimetry, Spectrophotometry, Chromatography, Gas Chromatography, Atomic Absorption Spectrophotometry, GLC, HPLC, Electrophoresis, X-ray fluorescence, X-ray diffraction, Flame photometry.

Course Objectives:

- To learn the role of biotechnology in environmental protection, bioplastic and green chemistry.
- To know how environmental technology useful in waste treatment, bioreactors and its application.
- To learn about bio- fuel, methane and hydrogen gas production, biopolymer and vermicompost.
- To learn regarding fundamentals of environmental chemistry.

Course Outcomes:

- Knowledge help in using eco-friendly products through green chemistry as well as bioplastics and biosensors for environmental monitoring.
- Learnt knowledge helps in waste (solid, liquid) management practices.
- Knowledge helps in guiding the use of biofuel, methane, vermicompost, bioplastic and biopolymer for sustainable ecosystem management.

Essential readings:

Abbasi, S.A. and E. Ramasami (1999) *Biotechnological Methods of Pollution Control*. Universities Press.

Bagyaraj, D.J. (2011) *Microbial Biotechnology for Sustainable Agriculture, Horticulture and Forestry*. New India Publishing Agency.

Das, M.K. (2008) *Environmental Biotechnology and Biodiversity Conservation*. Daya Publishing House, New Delhi.

De, A. K. (2010) *Environmental Chemistry* (7th edn.). New Age International Pvt. Ltd. Publishers, New Delhi.

Dubey, R.C. (1998) *A Textbook of Biotechnology*. S.Chand and Company Ltd. New Delhi.

Freedman, B. (1995) *Environmental Ecology: The Ecological Effects of Pollution, Disturbance and other Stresses.* Academic Press, New York.

Girard, J.E. (2011) *Principles of Environmental Chemistry* (2nd edn.). Jones and Bartlett India Pvt. Ltd., 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.

Manahan, S.E. (2011) *Fundamentals of Environmental Chemistry* (3rd edn.). CRC Press.

Subramanian, V. (2011) *A Textbook of Environmental Chemistry*. I K International Publishing House Pvt.Ltd.

Additional readings:

Liu, D.H.F. and Liptak, B. G. (2000) *Wastewater Treatment*. CRC Press. .

Singh, B. D. (1998) *Biotechnology*. Kalyani publishers.

Soetaert, W. and Vabdanne, E.J. (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 6 Marks 100

Unit I Microorganisms: Microbial evolution and Biodiversity; the place of microorganisms in nature; Prokaryotes and eukaryotes; Useful microorganisms; Growth and nutrition of microorganisms; Microbial community: Classification, structure and organisation; Species diversity.

Unit II Interactions between microorganisms and plants; Dispersal, interspecific relationships, symbiosis (i.e., the rhizosphere microflora, rhizobium root nodule symbiosis, mycorrhizal association); 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, actimonycetes, 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, vermicomposting; Microbial interactions with xenobiotic and inorganic pollutants; Bioremediation, biofertlisers; GM crops.

Essential readings:

Atlas, R. M. and Bartha, R. (2000) *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.

Gupta-Bhattacharya, M., Mandal, S. and Bhattacharya, K. and Dutta, N.M. (1998*) Current Concepts in Pollen Spore and Biopollution Research*. Studium Press.

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* (4th edn.). Oxford & IBH Publishing Co.Pvt. Ltd. New Delhi.

Additional readings:

Barton, L. L. and Northup, D. E. (2011) *Microbial Ecology*. Wiley-Blackwell Publishing.
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 6 Marks 100

Unit I **Environmental Monitoring:** Analytical approaches and instrumentation in environmental monitoring; Biomonitoring of air pollution - plants as biomonitors; Biomonitoring of running water pollution; Monitoring of environmental impact of mineral processing and smelting.

Unit II **Monitoring of toxicity and toxicants:** Acute and sublethal, chronic toxicity; pesticides in the environment, bioaccumulation and toxicity; Biochemical and ecological effects of heavy metals; Pathogenic contamination of water and health hazards.

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 **Issues in environmental management:** Organic farming and its ecological significance; Biomedical and hazardous waste management; Human use of groundwater, groundwater pollution and management; Constructed wetlands in wastewater treatment.

Unit V **Social and ethical issues:** Ethical issues in biotechnology; Ecosystem service – concept and application; Ecological footprint- concept, application and ethical implications; Animal welfare and ethics.

Course Objectives:

- Focus on pollution of the environment by emerging contaminants such as nanoparticles, endocrine-disrupting chemicals, etc.
- Introduce various concepts and principles of environmental toxicology, and frontier areas such as toxicogenomics, electromagnetic field radiation, organic farming, ethics of environmental biotechnology and ecological footprint, among others.
- Introduce the students to in-field, practical situations and issues.

Course Outcomes:

- Learn various approaches of monitoring environment and learn about the various toxicants present in our environment.
- Learn about various emerging areas and issues in the field of environment studies
- Learn about various social and ethical issues related to environment and its management.

Essential readings:

Abbasi, S.A., Abbasi, N. and Soni, R. (1998) *Heavy Metals in the Environment.* Mittal Publications, New Delhi.

Bitton, G. (2005) *Wastewater Microbiology* (3rd edn.). Johm 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. (2005) *Monitoring Ecological Change* (2nd). 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 (2010) *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.) (1999) *Bioresources and Biotechnology: Policy Concerns for the Asian region.* Gene Campaign, New Delhi.

Shrivastava, P. (2000) *Environmental Pollution and its Management*. APH Publishing Corporation, 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.

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

Lectures 45 Credit 6 Marks 100

Unit I Forest biodiversity: Concepts and dimensions, measures of forest diversity; Biodiversity in secondary forests; Biological invasion and forest biodiversity; Climate change and forest biodiversity; Phenological variation and climate change.

Unit II Agroforestry systems: Concept and classification (Structural, functional and ecological); Traditional agroforestry systems and biodiversity conservation with special emphasis on homegardens; Agroforestry and ecosystem services; Carbon sequestration in agroforestry systems; Shifting cultivation and management of fallows; National agroforestry policy.

Unit III Agrobiodiversity: Concept, management and conservation of agrobiodiversity, National action plan on agrobiodiversity; International treaty on plant genetic resources for food and agriculture; Ethnopedology and Local soil knowledge; *In situ* on farm conservation; Globally Important Agricultural Heritage Systems (GIAHS); National agricultural heritage sites; India's Plant Variety Protection and Farmers' Rights Act, 2002.

Unit IV Remote sensing and GIS: Introduction; Methods: Image acquisition; Image processing; Applications: Forest modelling and GIS, forest classification, forest structure estimation, forest change detection, forest biodiversity mapping; Agroforestry mapping.

Unit V Rules of naming plants: binomial nomenclature; naming of species, genus and family; rules for author citation; codes for plant nomenclature; National and International programmes on forest and agrobiodiversity conservation; Biodiversity information system and People's biodiversity register.

Course Objectives:

- To help the students learn about forest as an ecosystem and understand its concept properly.
- To enable student learn about the different group of forests such as primary and secondary forests and also apprise about its evolutionary significance.
- To help the students acquire survey and enumeration techniques for collection of different forest ecological aspects.
- To help the students learn about the climate change and its effect on biodiversity.
- To enable student learn about the different threats to biodiversity.
- To help students develop understanding about biological invasion and its role in degradation of the forest environment.
- To help students the role of agrobiodiversity and its concepts.
- To help the learn about the various international and national agricultural heritage sites and their role in conservation of agrobiodiversity.
- To help students garner knowledge about the various acts, treaties and action plans that are undertaken for the cause of agrobiodiversity preservation and conservation.
- To help the students appreciate the role of biodiversity information systems and people's biodiversity registers in preservation of agrobiodiversity.

Course Outcomes:

- Develop a better understanding of the dimensions of forest biodiversity and its intricacies.
- Acquire a thorough knowledge about the evolution of different forests and their community characteristics.
- Understand the concept of agrobiodiversity and its conservation aspects.
- Understand the various international and national initiatives undertaken for the conservation of agrobiodiversity.
- Acquire knowledge about the people's involvement in conservation efforts.

Essential readings:

Barnes, B.V., Zak, D.R., Denton, S.R. and Spurr, S.H. (1997) *Forest Ecology* (4th edn.). John Wiley and Sons.

Buck, L.E. Lassoie, J.P. and Fernandez, E.C.M. (2002) *Agroforestry in Sustainable Agricultural Systems*. CRC Press.

Cairns, M. (Ed.) (2015) *Shifting Cultivation and Environmental Change: Indigenous People, Agriculture and Forest Conservation*. Routledge.

Dagar, J.C., Singh, A.K. and Arunachalam, A. (Eds.) (2014) *Agroforestry Systems in India.* Springer.

Gaston, K.J. and Spicer, J.I. (2004) *Biodiversity: An Introduction* (2nd edn.). Wiley and Black.

Huston, M.A. (1994) *Biological Diversity*: *the Coexistence of Species in Changing Landscapes.* Cambridge University Press.

Jeffrey, Charles (1982) *An Introduction to Plant Taxonomy*. 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.

Mabberley, D.J. (2008) *Mabberley's Plant-Book- A Portable Dictionary of Plants, their Classifications and Uses* (3rd edn.). Cambridge University Press.

Maxted, N.; Ford-Lloyd, B.V. and Hawkes, J.G. (1997*) Plant Genetic Conservation: the In-situ Approach.* Chapman and Hall.

Magurran, A. and McGill, B.G. (2011) *Measuring Biological Diversity: Frontiers in Measurement.*Oxford University Press.

Nair, P.K.R. (1993) *An Introduction to Agroforestry*. Springer.

Ramakrishnan, P.S. (1992) *Shifting Agriculture and Sustainable Development: An Interdisciplinary Study from North Eastern India.*UNESCO-MAB.Parthenon Press, Paris, Parthenon Publications.

Schroth, G. *et al.* (2004) *Agroforestry and Biodiversity Conservation in Tropical Landscapes*. Island Press.

Singh, G. (2012) *Plant Systematics: Theory and Practice* (3rd edn.). Oxford and IBH, New Delhi.

Troup, R.S. (1921) *Silviculture of Indian Trees.* Vol. I-III. Clarendon Press, Oxford.

Additional readings:

Atangana, A., Khasa, D., Chang, S. Degrande, A. (2014) *Tropical Agroforestry*. Springer.

Darlong, V.T. (2004) *To Jhum or Not to Jhum: Policy Perspectives on Shifting Cultivation*. The Missing Link (TML), Society for Environment and Communication.

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.

Kumar, B.M. and Nair, P.K.R. (Eds.) (2011) *Carbon Sequestration Potential of Agroforestry Systems: Opportunities and Challenges.* Springer.

Lorenz, K. and Lal, R. (2009) *Carbon Sequestration in Forest Ecosystems*. Springer.

Nair, P.K.R. and Garrity, D. (Eds.) (2012) *Agroforestry: the Future of Global Land Use*. Springer.

Newton, A.C. (2007) *Forest Ecology and Conservation: A Handbook of Techniques*. Oxford University Press.

Ramakrishnan, P.S. (2008) *Cultural Cradle of Biodiversity*. National Book Trust.

Singh, B.P. and Srivastava, U. (2004) *Plant Genetic Resources in Indian Perspective- Theory and Practices*. ICAR, New Delhi.

Wood, D and Lenne (1999) *Agrobiodiversity: Characterisation, Utilisation and Management*. CABI.

ECG: 403 D

PEST MANAGEMENT AND ECOTOXICOLOGY
(Special Paper)
Lecture: 45 Credit 6 Marks 100

Unit I: Introduction: Concept of pest control and pest management; Classification of insects, ET and EIL, ecological highlights of pest, ecological role of insect-pests; the Idea of population, natality, mortality, growth form; Common sampling techniques in insect-pest management; Ecotoxicology.

Unit II: Ecological studies of major groups of insect-pests on: cucurbit and other vegetable crops, cruciferous, paddy, tea, stored grain, fibre and other important crops.

Unit III: Insect and host plant relationship, factors mediating the expression of resistance: physical factors, biological factors, traditional development of insect-resistant varieties, biotechnology and resistant variety development, successful uses of insect-resistant cultivars, pest biodiversity in various crops, conservation of beneficial predators.

Unit IV: Pest management theory, sustainable pest management practices, management by various indigenous/traditional methods, documentation of community based traditional method practices and their ecological consequences, pest management by biopesticides.

Unit V: History of pesticides evolution, classification, toxicity indication mark, nomenclature and formulation, The insecticides Act, 1968; The Insecticides Rule,1971; LVC and ULC spraying, median lethal doses, various methods of pest control mechanisms, concept of integrated pest management and practices, ecological consequences of integrated pest management.

Course Objectives:

- To learn the preliminary idea about pest management, insect ecology, ecological role of pests and ecotoxicology
- To know the ecological aspects of various pest diversities in vegetable, cash, fibre, oil, paddy crops and their ecological management practices
- To document traditional pest management knowledge practices used by various ethnic communities
- To encourage utilization of natural predators, microorganisms pathogens in management of pest species in agroecosystems
- To learn serious consequences of synthetic pesticides/insecticides in agroecosystems and idea about 'The Insecticide Act'

Course Outcomes:

- Learnt knowledge helps in monitoring and management of synthetic pesticides/insecticides in eco-friendly manner
- Use of plant indigenous materials, biopesticides, predators, pathogens, microorganisms are possible for target pest management avoiding use of toxic synthetic insecticides
- Through know –how, know-where knowledge the indigenous pest management practices utilised and encouraged various ethnic communities which are age old practices.

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 P.and Rice, M.E. (2014) *Entomology and Pest Management* (6th edn.). PHI Learning.

Additional readings:

Fenemore, P. G. and Prakash, A. (2006) *Applied Entomology*. New Age International Pvt.Ltd.

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., Ananthakrishnan, K. and David, B. V. (1985) *A Textbook on General and Applied Entomology*. Tata McGraw Hills Publishing Co. Ltd., New Delhi.

Norris, R.F., Caswell-Chen, E.P., and Kogan, M. (2002) *Concepts in Integrated Pest Management*. Prentice Hall India Pvt Ltd. (Indian Reprint), New Delhi.

Pimental, D. (1990) *Handbook of Pest Management in Agriculture* (2nd edn.). 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.

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ECG – 403 E

ALGAL ECOLOGY AND PHYSIOLOGY
(Special Paper)

Lectures 45 Credit 6 Marks 100

Unit I Algal ecology and distribution: Structure and classification of algae, phylogeny and taxonomy; Pigments, food reserves and extracellular products; Algal symbiosis in lichens, Azolla and other organisms; Ecology and distribution of Indian fresh water and marine algae.

Unit II Algal growth and development: Role of physico-chemical parameters in growth and development; Algal biodiversity and life-forms; Algae and biofilms; High-rate algal ponds; Top down and bottom-up community regulation and limitation, herbivory and grazing pressure on algae.

Unit III Algal survival and pollution: Algae and eutrophication; Toxicity and biofouling; Algal survival under physical and chemical stresses; Responses of algae to pollutants and heavy metals pollution; Uptake and accumulation of xenobiotic substances; Algal biomonitoring and bioassays of pollution, utilisation of algae in pollution removal; Harmful algal blooms (HAB) and algal toxins.

Unit IV Algal physiology: Nutritional requirements, nutrient cycling (carbon, nitrogen, phosphorous and silicon) in algae and nutrient uptake kinetics; Light harvesting unit in algae and photosynthesis, sun-shade adaptation; Carbon sequestration by algae; Respiration and biological oxidation; Nitrogenase complex and nitrogen fixation, nitrogen assimilation.

Unit V Algal biotechnology: Algal products and their uses; Algal sampling techniques, laboratory culture and mass cultivation of algae; Algal immobilisation; genetic manipulation and strain improvement; Algae as energy source, algal biofuels; Algal microcosms and mesocosms development and their role in ecorestoration, soil fertility and soil reclamation; Algal biofertilisers.

Course Objectives:

The course is intended to provide basic knowledge related to –

- Structure and classification of algae, phylogeny and taxonomy, ecology and distribution of Indian freshwater and marine algae
- Algal growth, biodiversity and life-forms, biofilms, High rate algal ponds, community regulation and limitation, grazing pressure on algae
- Algal survival under physical and chemical stresses, uptake and accumulation of xenobiotic substances, algal biomonitoring and bioassays of pollution, harmful algal blooms(HAB) and algal toxins
- Algal physiology: nutrient uptake, cycling (C, N, P and Si), light harvesting unit in algae, sun-shade adaptation; carbon sequestration by algae; nitrogen fixation, nitrogen assimilation.
- Algal biotechnology: laboratory culture and mass cultivation of algae; algal immobilisation; genetic manipulation, algae as energy source, biofuels and their role in ecorestoration, soil fertility and soil reclamation.

Course Outcomes:

The students are expected to learn about the following –

- Classification of algae, phylogeny and taxonomy, ecology and distribution of Indian freshwater and marine algae
- Physical and chemical stresses to algae, HAB, biomonitoring
- Carbon sequestration, light adaptation, N_2-fixation
- Genetic manipulation of algae, biofuel, bio-fertiliser, eco-restoration strategies

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*. Springer.

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* (2nd edn.). 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 6 Marks 100

Unit I **Wildlife habitat and population:** Characteristic of different forest ecosystems in N E India**;** Ecological role of wetland as a wildlife habitat; Some important wetlands of North East India; 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:** 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;

Unit III **Economic aspects, wildlife census:** Economic importance of wildlife; wildlife tourism; Trade on wildlife, wildlife crime; wildlife corridors; developmental activities versus wildlife conservation; Man –animal conflicts; wildlife population survey with reference to census techniques of rhino, tiger.

Unit IV **Wildlife conservation and other issues:** 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, impact of climate change in wildlife.

Unit V **Wildlife management, management planning:** Principles and strategies of wildlife management in protected areas; 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.

Course Objectives:

- To impart knowledge about the need, basic understandings and the importance of conservation of wildlife and their habitat.
- To get the students acquainted with the various categories of animals and their habitat that deserve attention of the conservationists.
- To create manpower who will work for the cause of wildlife and their habitat conservation.

Course Outcomes:

- Learn the basics objectives and purpose of wildlife conservation and apply them to solve the issues and challenges that hinder their conservation.
- Get acquainted with the various initiatives taken at the global and national level to protect the various wildlife.
- Train manpower for deployment in various Governmental institutions and NGOs that work in the field of Wildlife and biodiversity conservation.

Essential readings:

Ali, S. and Riopley, S.D. (1987) *Compact Handbook of the Birds of India and Pakistan* (2nd edn.). Oxford University Press.

Anonymous. (2004) *The Wildlife Protection Act, 1972 (as amended up to 2004)*.Natraj Publisher, Dehradun.

Choudhury, A. (1997) *The Birds of Assam*. Gibbon Books and WWF.

Choudhury, A. (2000) *The Mammals of North East India*. Gibbon Books and Rhino Foundation.

Colin, J., Bibby, Burgess, N.D. and Hill, D.A. (2011) *Bird Census Techniques*. Academic Press.

Das, C. (2007) *A Treatise on Wildlife Conservation in India.* Eastern Book Corporation, New Delhi.

Gopal, R. (2011) *Fundamentals of Wildlife Management*. Natraj Publishers.

Jacobson, S.K. (2002) *Conserving Wildlife.* Eastern Book Corporation, New Delhi.

Johnsing, A.J.T. and Manjrekar, N. (Eds.) (2015) *Mammals of South Asia*. Vol.1.Universities Press of India Pvt.Ltd., Hyderabad.

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.

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.

Woodroffe, R., Thirgood, S. and Rabinowitz, A. (Eds.) (2005) *People and Wildlife: Conflict or Coexistence?* Cambridge University Press.

Additional readings:

Ahmed, M. F., Das, A and Dutta, S. K. (2009) *Amphibians and Repliles of Northeast 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.

Menon, V. (2013) *Indian Mammals: A Field Guide.* Hachette India, New Delhi.

Rahmani, A.R. and Choudhury, A.U. (2012) *Threatened Birds of Assam.* Oxford University Press.

Rasmussen, P. C. and Anderton, J.C. (2012) *Birds of South Asia: The Ripley Guide* (2nd edn.). Lynx Edicions.

ECG – 403 G
ETHNOBOTANY AND CONSERVATION OF MEDICINAL PLANTS

(Special Paper)

Lectures 45 Credit 6 Marks 100

Unit I Ethnobotany: Definition, concept, scope and relevance as interdisciplinary Science; Ethnobotany VS Ethnobiology; Ethnopharmacology; Dynamism in ethnobotany; Ethnobotany in human welfare; India's contribution to ethnobotanical studies with particular reference to N.E. India; Main World's Centres and workers in Ethnobotany; Credibility of traditional knowledge.

Unit II Objectives of ethnobotany: knowledge traditional, approaches modern, Methods and techniques in ethnobotanical study; Sources of Ethnobotanical materials; Collection and processing of plants for biological screening; Importance of Traditional Botanical Knowledge (TBK); Importance of Herbaria for the Ethnobotanical study; Plants in Magico-religious beliefs, social customs and taboos & associated plants.

Unit III Role of herbal practitioner; case study of utilization of products of plants and minerals origin; Ethnoveterinary medicine and its importance; Wild edible plants; Practical application in ethnobotany; Role of Ethnobotany in search of new medicinal plants; Cross-cultural ethnobotanical study; Economic development of Backward people; Community & farmers' rights; Ethnomedicine and discovery of new drugs; Intellectual property rights (IPR) & Biosafety; Traditional Knowledge digital library (TKDL).

Unit IV Orientation discipline in Ayurveda: Its Medicobotanical approaches and their application in evolution of drugs; Agropractice and commercial cultivation of medicinal plants: *Amla, Aswagandha, Brahmi, Chandan, Hartaki, Sarpagandha, & Tulsi;* Phytochemistry- Basic principle in relation to ethnobotany & Human welfare; Isolation, Chromatography, Micromolecules: Secondary metabolites; Alkaloids, Flavonoids, Terpenoids & Steroids; Phenolic constituents. Pharmacognosy- introduction, interdisciplinary nature and scope; Production, Utilization and Marketing of Agricultural and Non-timber forest products.

Unit V Principle and practice of medicinal plant conservation; Conservation strategies of ethnomedicinal plants of N.E. India; Conservation Goals, Economic costs & benefits of conservation; Livelihood of Tribals vis-a vis forest management; *Ex-situ* and *In-situ* conservation; Sacred Groves; Traditional ethics towards the conservation of medicinal plants.

Course Objectives:

- To know about the History of Man-plant interactions, their way of utilization mechanism and dependency on Forest products.
- To know about Agro-practice Commercial cultivation of Medicinal plants.
- Phytochemical and Pharmacological study of Medicinal plants.
- Conservation and management of Ethnobotanical plants through traditional and Modern techniques.

Course Outcomes:

- Students learn about the Importance of Ethnobotanical study & credibility of Traditional knowledge.

- Students learn about the commercial cultivation of plants and they may aware about the mass people about commercial cultivation.
- Students understand about Phytoconstituent / phytochemicals and its importance on Human health.
- Can able to practice traditional conservation mechanisms and also modern technique in medicinal plants also IUCN red listed categorized plants for the interest of Human society.
- Learners helps the poor stakeholders in the villages regarding uses of various ethnobotanical plant parts for their daily life / day to use/ cure ailments.
- They understand about Intellectual Property Right and it's application.

Essential readings:

Basu, S.K. and Chakraborty, R.K. (1994) *A Manual of Cultivated Palms in India.* Botanical Survey of India.

Cordell, G.A. (1997) *The Alkaloids: Chemistry and Biology.* Academic Press, London, U.K.

Cotton, C.M. (1966) *Ethnobotany: Principles and Applications*. John Wiley & Sons, New York.

Das, Ajit Kumar, Dutta, B.K., Sharma, G.D. and Hajra, P.K. (2010) *Medicinal Plants of Southern Assam.* Deep Publication, New Delhi.

Deorani, S.C. and Sharma, G.D. (2007) *Medicinal Plants of Nagaland.* Bishen Singh and Mahendra Pal Singh, Dehradun.

Duke, J. A. (1992) *Handbook of Biologically Active Phytochemicals and their Activities*. CRC Press. Boca Raton, Flor., U.S.A.

Farooqi, A.A. and Sreeramu, B.S. (2001) *Cultivation of Medicinal and Aromatic Crops.* Universities Press (India) Limited, Hyderabad, India.

Ford, R.I. (2001) *Ethnobiology at the Millenium: Past Promise and Future Prospects.* University of Michigan Museum.

Hussain, A. (1993) *Medicinal Plants and their Cultivation*. Central Institute of Medicinal and Aromatic Plants, Lucknow.

Jain, S.K. (Ed.) (1981) *Glimpses of Indian Ethnobotany*. Oxford & IBH, New Delhi.

Jain, S.K. (Ed.) (1985) *Ethnobiology in Human Welfare*. Deep Publications. New Delhi.

Jain, S.K. (1987) *A Manual of Ethnobotany*. Scientific Publishers, Jodhpur.

Jain, S.K. (Assist. by S. Srivastava) (1998) *Dictionary of Ethnoveterinary Plants*. Deep Publications, New Delhi.

Jain, S.K. and Jain, A.K. (2013) *An Introduction to Ethnobotany*. Deep Publication, New Delhi.

Mathias, E., Rangnekar, D.V. and McCorkle, C.M. (Ed.) (1999) *Ethnoveterinary Medicine - Alternative for Livestock Development.* BAIF Development Research Foundation, Pune.

Schultes and Reissvon (1995) *Ethnobotany: Evolution of a Discipline*. Chapman and Hall.

ECG-404 (A/B/C/D/E/F/G)

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

Credit 12 Marks 200

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
ECG 403G: Ethnobotany and Conservation of Medicinal Plants