M. Sc. Program in Conservation Biology
(With effect from the session 2019-2020)
[Choice Based Credit System]

Department of Conservation Biology
Kazi Nazrul University
Asansol, Paschim Bardhaman,
West Bengal, India, 713340

POST GRADUATE SYLLABUS
Program - M.Sc. CONSERVATION BIOLOGY
Summary of the course and credits

	Core Course		Major Elective Course		Extra Departmental Elective Course	Dissertation	Total credits
	Theory	Practical	Theory	Practical			
Semester - I	16	4	-	-	-	-	20
Semester - II	16	4	-	-	4	-	24
Semester - III	12	2	4	2	4	-	24
Semester - IV	8	2	4	2	-	4	20
Total	**52**	**12**	**08**	**4**	**8**	**4**	**88**

- **Core Courses**: Every student will take only core courses in the Semesters I and II while they will take core courses along with the other courses in the Semesters III and IV

- **Major Elective Courses (Specialization):** Students will choose one major elective (out of four) from Semester III and choose the same major elective from Semester IV accordingly

- **Extra Departmental Elective (Minor Elective)**: Students will have to earn at least 4 credits (50 marks) from an extra departmental elective that they will pursue from another department of the Kazi Nazrul University during II Semester* and during III Semester

- **Dissertation**: Students will submit one Dissertation based on Major Elective Course in the Semester IV. However, they can initiate the work from the Semester III

- In each course, 20% marks is allotted for Internal Assessment (for theory paper) and 60% marks is allotted for Internal Assessment (for practical paper), i.e., 10 marks for each theory paper of 50 marks including Project Work/ Term Paper in form of assignments, paper presentation, reports, debates, PowerPoint presentation etc. and 30 marks for each practical paper of 50 marks including internal practical assessment.

- Marks distribution for each paper (End semester Examination)will be as follows: Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

*May be opted by II Semester PG Students of Kazi Nazrul University, except the students of M.Sc. Conservation Biology.

SEMESTER – I [Credits – 20]							
COURSE CODE	**COURSE**	**DIVISION**	**CORE / MAJOR ELECTIVE**	**L:T:P**	**CREDIT POINT**	**EXAM HOURS (Theory and Practical)**	**FULL MARKS**
MSCCONBC 101	BIOGEOGRAPHY AND BIOLOGICAL RESOURCES I	THEORY	CORE CC-1	4:0:0	4	2	50 (10 + 40)
MSCCONBC 102	NATURAL INTERACTIONS I	THEORY	CORE CC-2	4:0:0	4	2	50 (10 + 40)
MSCCONBC 103	BIOMES AND RESOURCES	THEORY	CORE CC-3	4:0:0	4	2	50 (10 + 40)
MSCCONBC 104	ECOLOGICAL PRINCIPLES	THEORY	CORE CC-4	4:0:0	4	2	50 (10 + 40)
MSCCONBC 105	BIOGEOGRAPHY AND BIOLOGICAL RESOURCES II	PRACTICAL	CORE CC-5	0:0:4	2	5	50 (30 + 20)
MSCCONBC 106	NATURAL INTERACTIONS II	PRACTICAL	CORE CC-6	0:0:4	2	5	50 (30 + 20)
Total Semester I (Theory + Practical) = 300 Marks				**Total Semester I Core Credit Points = 20**			

SEMESTER – II [Credits – 24]							
COURSE CODE	**COURSE**	**DIVISION**	**CORE / ELECTIVE**	**L:T:P**	**CREDIT POINT**	**EXAM HOURS (Theory and Practical)**	**FULL MARKS** (INTERNAL + EXTERNAL)
MSCCONBC 201	CHEMISTRY IN NATURAL MANAGEMENT	THEORY	CORE CC-7	4:0:0	4	2	50 (10 +40)
MSCCONBC 202	BIOLOGICAL RARITY PHENOMENA	THEORY	CORE CC-8	4:0:0	4	2	50 (10 +40)
MSCCONBC 203	BIODIVERSITY CONSERVATION I	THEORY	CORE CC-9	4:0:0	4	2	50 (10 +40)
MSCCONBC 204	CHEMISTRY OF BIOSPHERE I	THEORY	CORE CC-10	4:0:0	4	2	50 (10 +40)
MSCCONBC 205	BIODIVERSITY CONSERVATION II	PRACTICAL	CORE CC- 11	0:0:4	2	5	50 (30 +20)
MSCCONBC 206	CHEMISTRY OF BIOSPHERE II	PRACTICAL	CORE CC- 12	0:0:4	2	5	50 (30 +20)
MSCCONBMIE 201	BASIC CONSERVATION BIOLOGY	THEORY	MINOR ELECTIVE MIE -1	4:0:0	4	1	50 (10 +40)
Total Semester II (Theory + Practical) = 350 Marks				**Total Semester II Core Credit Points = 24**			

SEMESTER – III [Credits – 24]

COURSE CODE	COURSE	DIVISION	CORE / MAJOR ELECTIVE	L:T:P	CREDIT POINT	EXAM HOURS (Theory and Practical)	FULL MARKS (INTERNAL + EXTERNAL)
MSCCONBC 301	NATURAL RESOURCE MANAGEMENT	THEORY	CORE CC- 13	4:0:0	4	2	50 (10 + 40)
MSCCONBC 302	WILDLIFE MANAGEMENT	THEORY	CORE CC- 14	4:0:0	4	2	50 (10 + 40)
MSCCONBC 303	QUANTIFICATION TECHNIQUES I	THEORY	CORE CC - 15	4:0:0	4	2	50 (10 + 40)
MSCCONBC304	QUANTIFICATION TECHNIQUES II	PRACTICAL	CORE CC - 16	0:0:4	2	5	50 (30 + 20)
MSCCONBMJE301	FOREST WEALTH -I	THEORY (OPTION A)	MAJOR ELECTIVE MJE - 1	4:0:0	4	2	50 (10 + 40)
MSCCONBMJE302	FOREST WEALTH -II	PRACTICAL (OPTION A)	MAJOR ELECTIVE MJE - 2	4:0:0	2	5	50 (30 + 20)
MSCCONBMJE303	WETLAND CONSERVATION - I	THEORY (OPTION B)	MAJOR ELECTIVE MJE - 3	4:0:0	4	2	50 (10 + 40)
MSCCONBMJE304	WETLAND CONSERVATION - II	PRACTICAL (OPTION B)	MAJOR ELECTIVE MJE - 4	4:0:0	2	5	50 (30 + 20)
MSCCONBMJE305	CONSERVATION GENETICS - I	THEORY (OPTION C)	MAJOR ELECTIVE MJE - 5	0:0:4	4	2	50 (10 + 40)
MSCCONBMJE306	CONSERVATION GENETICS - II	PRACTICAL (OPTION C)	MAJOR ELECTIVE MJE - 6	0:0:4	2	5	50 (30 + 20)
MSCCONBMJE307	MARINE BIORESOURCES- I	THEORY (OPTION D)	MAJOR ELECTIVE MJE - 7	0:0:4	4	2	50 (10 + 40)
MSCCONBMJE308	MARINE BIORESOURCES- II	PRACTICAL (OPTION D)	MAJOR ELECTIVE MJE - 8	0:0:4	2	5	50 (30 + 20)
IMSCCONBMIE301	CONSERVATION LAW AND MANAGEMENT	THEORY	MINOR ELECTIVE MIE -2	4:0:0	4	1	50 (10 + 40)
Total Semester III (Theory + Practical) = 350 Marks				**Total Semester III Credit Points = 24**			

SEMESTER – IV [Credits – 20]

COURSE CODE	COURSE	DIVISION	CORE / MAJOR ELECTIVE	L:T:P	CREDIT POINT	EXAM HOURS (Theory, Practical and presentation)	FULL MARKS (INTERNAL + EXTERNAL)
MSCCONBC 401	BIOINFORMATICS and COMPUTER APPLICATIONS	THEORY	CORE CC-17	4:0:0	4	2	50 (10 + 40)
MSCCONBC 402	BIOSTATISTICS and BIOINSTRUMENTATION	THEORY	CORE CC-18	4:0:0	4	2	50 (10 + 40)
MSCCONBC 403	DISSERTATION	PRACTICAL	CORE CC-19	0:0:8	4	5	50 (30 + 20)

MSCCONBC 404	BIOINFORMATICS, BIOSTATISTICS and COMPUTER APPLICATIONS	PRACTICAL	CORE CC-20	0:0:4	2	5	50 (30 + 20)
MSCCONBMJE401	FOREST WEALTH -III	THEORY (OPTION A)	MAJOR ELECTIVE MJE - 9	4:0:0	4	2	50 (10 + 40)
MSCCONBMJE402	FOREST WEALTH -IV	PRACTICAL (OPTION A)	MAJOR ELECTIVE MJE - 10	4:0:0	2	5	50 (30 + 20)
MSCCONBMJE403	WETLAND CONSERVATION - III	THEORY (OPTION B)	MAJOR ELECTIVE MJE - 11	4:0:0	4	2	50 (10 + 40)
MSCCONBMJE404	WETLAND CONSERVATION - IV	PRACTICAL (OPTION B)	MAJOR ELECTIVE MJE - 12	4:0:0	2	5	50 (30 + 20)
MSCCONBMJE405	CONSERVATION GENETICS - III	THEORY (OPTION C)	MAJOR ELECTIVE MJE - 13	0:0:4	4	2	50 (10 + 40)
MSCCONBMJE406	CONSERVATION GENETICS - IV	PRACTICAL (OPTION C)	MAJOR ELECTIVE MJE - 14	0:0:4	2	5	50 (30 + 20)
MSCCONBMJE407	MARINE BIORESOURCES- III	THEORY (OPTION D)	MAJOR ELECTIVE MJE - 15	0:0:4	4	2	50 (10 + 40)
MSCCONBMJE408	MARINE BIORESOURCES- IV	PRACTICAL (OPTION D)	MAJOR ELECTIVE MJE - 16	0:0:4	2	5	50 (30 + 20)
Total Semester IV (Theory + Practical) = 300 Marks				**Total Semester IV Credit Points = 20**			

ACRONYMS:
MSC: **M**ASTER OF **S**CIENCE;
MSCCONBC: **M**ASTER OF **S**CIENCE IN **CON**SERVATION **B**IOLOGY **C**ORE; MSCCONBMIE: **M**ASTER OF **SC**IENCE IN **CON**SERVATION **B**IOLOGY **MI**NOR **E**LECTIVE;
MSCCONBMJE: **M**ASTER OF **SC**IENCE IN **CON**SERVATION **B**IOLOGY **MAJ**OR **E**LECTIVE

MAJOR ELECTIVES

1. FOREST WEALTH
2. WETLAND CONSERVATION
3. CONSERVATION GENETICS
4. MARINE BIORESOURCES

MINOR ELECTIVES

1. BASIC CONSERVATION BIOLOGY
2. CONSERVATION LAW AND MANAGEMENT

OUTLINE OF 1ST SEMESTER COURSE CONTENTS
SEMESTER-I

MSCCONBC101: Biogeography and Biological Resources I Core, 4 credits, 50 marks

Theory

101.1 Biogeography (10.0 Lectures)

101.2 Ecosystems (10.0 Lectures)

101.3 Systematics (5.0 Lectures)

101.4 Vegetation and forest types (15.0 Lectures)

101.5 Use of bioresources and Conservation ethics (10.0 Lectures)

MSCCONBC102: Natural Interactions I Core, 4 credits, 50 marks

Theory

102.1 Environmental Systems (10.0 Lectures)

102.2 Environmental Crisis and Pollution (10.0 Lectures)

102.3 Ecotoxicology (10.0 Lectures)

102.4 Management of Degraded Nature (10.0 Lectures)

102.5Climate Chemistry (10.0 Lectures)

MSCCONBC103: Biomes and Resources Core, 4 credits, 50 marks

Theory

103.1 Freshwater and Wetland Habitats (10.0 Lectures)

103.2 Marine and Desert Habitats (10.0 Lectures)

103.3 Alpine and Grassland Habitats (10.0 Lectures)

103.4 Resources: Concept and Causes of Depletion (10.0 Lectures)

103.5 Use and over-exploitation of Resources (10.0 Lectures)

MSCCONBC104: Ecological Principles Core, 4 credits, 50 marks

Theory

104.1Population Ecology (10.0 Lectures)

104.2Community Ecology (10.0 Lectures)

104.3Molecular and Microbial Ecology (10.0 Lectures)

104.4Behavioral Ecology (10.0 Lectures)

104.5Evolutionary Ecology (10.0 Lectures)

MSCCONBC105: Biogeography and Biological Resources II Core, 2 credits, 50 marks

Practical

105.1 Laboratory Course (10 marks)

105.2 Field Study and Report Presentation (10 marks)

MSCCONBC106: Natural Interactions II Core, 2 credits, 50 marks

Practical

106.1 Laboratory Course (10 marks)

106.2 Case Studies and Report Presentation (10 marks)

SEMESTER - I

MSCCONBC101: Core Course
(Biogeography and Biological Resources I)
(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about biogeography, ecosystems and vegetation types*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

101.1 ***Biogeography***: (10 Lectures)

Biogeographical concepts, dispersal and faunal exchange, barriers, mode of dispersal, origins and radiation. Biogeographical process, endemism, refugia. Continental drift with special emphasis on plate tectonic theory; dispersal, biogeographical realms and provinces. Phytogeographical regions of world. Origin of flora and fauna of India, routes of faunal exchange and migration

101.2 ***Ecosystems***: (10 Lectures)

Abiotic and biotic components; producers, consumers and decomposers. Communities, populations. Energy flow and nutrient cycles, trophic equilibrium; food chains, food webs, trophic levels; biogeochemical cycles: N, P and C. self-sustainability of natural ecosystems

101.3 ***Systematics:*** (5 Lectures)

Systems of classification: phenetics, cladistics; principles of nomenclature: ICN, ICNB, ICZN; Type concept

101.4 ***Vegetation and forest types:*** (15 Lectures)

Origin of vegetation, relationship between environmental factors and vegetation types with special reference to India. Champion and Seth's classification of Indian forests. Plant succession and retrogression: concepts and processes. Plant strategies and life histories. Phenology and productivity. Resource competition and coexistence. Regenerative strategies and socio-biology of plants. Classification of plant communities.

101.5 ***Use of Bioresources and Conservation Ethics***: (10 Lectures)

Diverse uses of bioresources; Causes of overexploitation of bioresources; importance of conservation. Social movements concerning conservation issues; Patent Right: Property and patent, application, implication and protection of patent

Suggested readings:

Caughley, G., and A. Gunn. 1996. Conservation Biology in Theory and Practice. Blackwell Science, Cambridge, Massachusetts, U.S.A.

Cox, G. W. 2005. Conservation Biology: Concepts and Applications. McGraw-Hill, Dubuque, Iowa, U.S.A.

Dasmann, Raymond Fredric, 1981. Wildlife Biology, 2nd ed. John Wiley and Sons, NY.

Dobson, A. P. 1996. Conservation and Biodiversity. Scientific American Library, New York, New York, U.S.A.

Hunter Jr., M. L. 2002. Fundamentals of Conservation Biology. Blackwell Science, Malden, Massachusetts, U.S.A.
Jeffries, M. J. 1997. Biodiversity and Conservation. Routledge, New York, New York, U.S.A.
Leveque, C., and J.-C. Mounolou. 2003. Biodiversity. John Wiley and Sons, West Sussex, England.
Lyndermayer D. B.and J. F. Franklin, 2002. Conserving forest biodiversity: a comprehensive multiscaled approach. Island Press, Covello.
Hunter,M. and J. Gibbs 2006. Fundamentals of Conservation Biology, Third Edition.Blackwell Publ.NY.
MacDonald, D. 2006. Key Topics in Conservation Biology. Blackwell Publishing.
Marty, P., F.D. Vivien, J. Lepart, and R. Larrere, (eds.) 2005. Les Biodiversites: Objets, Theories, Pratiques. CNRS Editions, Paris, France.

MSCCONBC102: Core Course
(Natural Interactions I)
(Credit 4)

Learning Outcome: At the end of this course the students will have an idea about environmental crisis, pollution and climate chemistry

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, two questions (out of four) of 8 mark each, and are to be answered

102.1 ***Environmental Systems***: (10 Lectures) Concept of isolated, close, open and interactive systems, dynamics and equilibrium of different systems, entropy and free energy structure, Structure and dynamics of Earth (atmosphere, hydrosphere, lithosphere, biosphere), Gaia hypothesis.

102.2 ***Environmental Crisis and Pollution***: (10 Lectures) Sources and effects of different kinds of pollution: Air, water, soil, and noise; effect of Magnetic and Electrical and radioactive fields; stratospheric and tropospheric pollution; atmospheric aerosols; urban and Indoor pollution

102.3 ***Ecotoxicology:*** (10 Lectures) Types of health hazards, dose response relationships, Effects of organic biocides – pesticides, insecticides, herbicides, PCBs, Dioxins, PAH - their stability, mobility, leachability, GUS index.

102.4 ***Management of Degraded Nature / soil resources:*** (10 Lectures) Degradation, erosion and conservation of soil; factors affecting soil erosion; estimation of rate of soil erosion, methods to control soil erosion, reclamation of soil; phytoremediation, soil washing, immobilization techniques, bioremediation of oil spilled shore line, restoration of open cast mining sites, control of coastal erosion and coastal flooding, land reclamation with industrial wastes

102.5 ***Climate Chemistry: Changes and Consequences:*** (10 Lectures)

Chemicals that initiate changes in global climate; marine eutrophication and DMS initiated changes; greenhouse gases and CFC on climate change in global scale.

Suggested readings:

Sinclair, A. R. E., J. M. Fryxell, and G. Caughley. 2006. Wildlife Ecology, Conservation and Management. Blackwell Publishing.

Soulé M. E. (ed.) 1986. Conservation biology: the science of scarcity and diversity- Sinauer, Sunderland.

Soulé M. E. (ed.) 1987. Viable populations for conservation. Cambridge University Press, Cambridge.

Board on Science and Technology for International Development. 1992. Conserving Biodiversity: A Research Agenda for Development Agencies. U.S. National Research Council, Washington, D.C., U.S.A.

Bradstock, R. A., T. D. Auld, D. A. Keith, R. T. Kingsford, D. Lunney, and D. P. Sivertsen, (eds.) 1995. Conserving Biodiversity: Threats and Solutions. Surrey Beatty and Sons, Chipping Norton, Australia.

Caughley, G., and A. Gunn. 1996. Conservation Biology in Theory and Practice. Blackwell Science, Cambridge, Massachusetts, U.S.A.

Cox, G. W. 2005. Conservation Biology: Concepts and Applications. McGraw-Hill, Dubuque, Iowa, U.S.A.

Dasmann, R. F., 1981. Wildlife Biology, 2nd ed. John Wiley and Sons, NY.

MSCCONBC103: Core Course
(Biomes and Resources)
(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about different biomes and resources*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, two questions (out of four) of 8 mark each, and are to be answered

103.1 ***Wetlands***: (10 Lectures)

Wetlands: classification, functions and values. Physical, chemical and anthropogenic factors influencing wetland habitats; Ramsar Sites

103.2 ***Marine and Desert***: (10 Lectures)

Physical and chemical characteristics of the marine and desert environment, structure of the sea (upwelling and downwelling), bathymetric distribution of biota of the sea, microbial flora of the sea; desert: types and distribution; desertification; desert biota

103.3 ***Alpine and grasslands***: (10 Lectures)

Physical and chemical characteristics; flora and fauna; threats; productivity of grasslands

103.4 ***Resources: Concept and Causes of Depletion***: (10 Lectures)

Renewable and non-renewable resources; global distribution and exploitation of resources; equitable use of resources for sustainable lifestyles; role of an individual and organizational efforts in conservation of natural resources; integrating development and conservation

103.5 ***Use and Over-exploitation of Resources***: (16 Lectures)
Deforestation: Causes and consequences of deforestation; peoples' efforts in conservation of forest wealth of India. Conflicts over water, dams- benefits and problems. Environmental effects of mining; use of microbes in mineral extraction, conservation of mineral resources. Fertilizer-pesticide problems in agriculture

Suggested readings:

Dasmann, R. F., 1981. Wildlife Biology, 2nd ed. John Wiley and Sons, NY.

Hunter, Jr., M. L. 2002. Fundamentals of Conservation Biology. Blackwell Science, Malden, Massachusetts, U.S.A.

Jeffries, M. J. 1997. Biodiversity and Conservation. Routledge, New York, New York, U.S.A.

Leveque, C., and J.C. Mounolou. 2003. Biodiversity. John Wiley and Sons, West Sussex, England.

Lyndermayer D. B. and J. F. Franklin. 2002. Conserving forest biodiversity: a comprehensive multiscaled approach. Island Press, Covello.

Mills, L. Scott 2006. Conservation of Wildlife Populations. Blackwell Science, Oxford, U. K.

Milner-Gulland, E. J., and R. Mace. 1998. Conservation of Biological Resources. Blackwell Science, Oxford, U.K.

Moritz, C., and J. Kikkawa. 1994. Conservation Biology in Australia and Oceania. Surrey Beatty and Sons, Chipping Norton, Australia.

Morris Gosling L.and W. J. Sutherland (eds) 2000. Behaviour and Conservation. Cambridge University Press, Cambridge.

Morris, W. F., and D. F. Doak. 2002. Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis. Sinauer Associates, Sunderland, Massachusetts, U.S.A.

Mulder, M. B., and P. Coppolillo. 2005. Conservation: Linking Ecology, Economics, and Culture. Princeton University Press, Princeton, New Jersey, U.S.A.

MSCCONBC104: Core Course
(Ecological Principles)
(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about ecological principles, behavior and evolution*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, two questions (out of four) of 8 mark each, and are to be answered

104.1 ***Population Ecology***: (10 Lectures) Demographic and life history parameters, r and K selection, allometry, aging and sexing, life tables, age and stage structures models, population dynamics: exponential, logistic and other forms of growth of population, density dependent and independent growth, Lotka-Voltera equation

104.2 ***Community Ecology***: (10 Lectures) Community structure: concept of dominance, diversity, spatial structure, ecological niche, assembly rules, guilds, ecotones. Community change: concept of disturbance, succession, climax, phenology, seasonal patterns; Community productivity and energy flow; ecological efficiency, detritus vs. grazing food chains. Brief idea about community genetics

104.3 ***Molecular and Microbial Ecology***: (10 Lectures) Ecological groups of microorganisms, extremophiles, microbial interactions; plant-microbe,
animal-microbe and microbe-microbe interactions; mycorrhiza, microbes in biogeochemical cycles; microbial interactions with pollutants and xenobiotics; microbial control of pests and diseases.

104.4 ***Behavioural Ecology***: (10 Lectures)
Behavioral genetics, types and levels of selection, foraging and optimality theory, foraging and biotic interactions, predator-prey interactions competing for resources, territorial behavior, fighting – game theory, parental favoritism and caring for strangers; altruism – relatives and non-relatives, helping and cooperation, learning, communication, honesty, deception; migration and dispersal.

104.5 ***Evolutionary Ecology***: (10 Lectures) Phenotypic plasticity; life history strategies – age and sex at maturity, offspring size and number; sexual selection, mating systems, alternative breeding strategies. Co-evolution

Suggested readings:

Sinclair, A. R. E., J. M. Fryxell, and G. Caughley. 2006. Wildlife Ecology, Conservation and Management. Blackwell Publishing.

Soulé M. E. (ed.) 1986. Conservation biology: the science of scarcity and diversity- Sinauer, Sunderland.

Soulé M. E. (ed) 1987. Viable populations for conservation. Cambridge University Press, Cambridge.

Board on Science and Technology for International Development. 1992. Conserving Biodiversity: A Research Agenda for Development Agencies. U.S. National Research Council, Washington, D.C., U.S.A.

Bradstock, R. A., T. D. Auld, D. A. Keith, R. T. Kingsford, D. Lunney, and D. P. Sivertsen, (eds.) 1995. Conserving Biodiversity: Threats and Solutions. Surrey Beatty and Sons, Chipping Norton, Australia.

Caughley, G., and A. Gunn. 1996. Conservation Biology in Theory and Practice. Blackwell Science, Cambridge, Massachusetts, U.S.A.

Cox, G. W. 2005. Conservation Biology: Concepts and Applications. McGraw-Hill, Dubuque, Iowa, U.S.A.

Dasmann, R. F. 1981. Wildlife Biology, 2nd ed. John Wiley and Sons, NY.

PRACTICAL PAPERS
MSCCONBC105:
(Biogeography and Biological resources II)
Core Course
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to learn and perform various methods of assessment of biodiversity (flora and fauna) through various field activities*

Time – 5 hrs **Full Marks: 50**

1. Determination of log volume
2. Mapping structural, ecological and floristic associations
3. Study of freshwater biota: pond, riverine, wetland, rice field
4. Study of grassland and its productivity
5. Study of marine biota and analysis of structure of plankton community
6. Study of different diversity indices for community analysis
7. Field study of any ecosystem
8. Laboratory record
9. Viva-voce

PRACTICAL PAPERS
MSCCONBC106:
(Natural Interactions II)
Core Course
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to learn and perform the methods to collect, measure and analyze environmental data related to soil and water*

Time – 5 hrs **Full Marks: 50**

1. Experimental analysis: measurement of rainfall, air temperature, humidity, wind speed; dose-response relationship; LC_{50}; titrimetric analysis of water: Chloride, Hardness (total, Calcium, Magnesium), Alkalinity, Acidity, residual chlorine, dissolved oxygen, water carbondioxide; pH and conductivity of water, TDS, TSS.
2. Demonstration: UV-Vis spectrophotometer, AAS, HPLC, PCR, TLC, Agarose and PAGE
3. Case studies related to degraded ecosystem from mining and deforestation, fertilizer-pesticide problem and other studies related to soil, water and noise pollution
4. Seawater analysis
5. Laboratory visit
6. Laboratory record
7. Viva-voce

OUTLINE OF 2ND SEMESTER COURSE CONTENTS
SEMESTER-II

MSCCONBC201: Chemistry In Natural Management core 4 credits 50 marks
Theory

201.1 Wastewater Management (10.0 Lectures)
201.2 Solid Waste Management (5.0 Lectures)
201.3 Green Reagents and Green catalysts (10.0 Lectures)
201.4 Reactions in Green Chemistry and Green Synthesis (15.0 Lectures)
201.5 Biotic Health (10.0 Lectures)

MSCCONBC202: Biological Rarity Phenomena core 4 credits 50 marks
Theory

202.1 Rates of Extinction and Forms of Rarity (10.0 Lectures)
202.2 Reproductive Strategies (10.0 Lectures)
202.3 Inbreeding and Outbreeding Depression (10.0 Lectures)
202.4 Fragmentation and Metapopulation (10.0 Lectures)
202.5 Minimal Viable Population and Polpulation vialbility analysis (10.0 Lectures)

MSCCONBC 203: Biodiversity Conservation I core 4 credits 50 marks
Theory

203.1 Biodiversity: Definition, Concept and Values (10.0 Lectures)
203.2 Levels of and Threats to Biodiversity (10.0 Lectures)
203.3 Hotspots and Megadiversity Countries (10.0 Lectures)
203.4 Endangered and Endemic species of India (10.0 Lectures)
203.5 In-situ and Ex-situ Conservation (10.0 Lectures)

MSCCONBC204: Chemistry of Biosphere core 4 credits 50 marks
Theory

204.1 Chemistry in Biosphere Conservation: Global Perspective (10.0 Lectures)
204.2 Chemistry of Atmosphere and Global Climate (10.0 Lectures)
204.3 Chemistry of Hydrosphere (10.0 Lectures)
204.4 Chemistry of Lithosphere (10.0 Lectures)
204.5 Global Climate Change: Causes and Consequences (10.0 Lectures)

MSCCONBC205: Biodiversity Conservation II core 2 credits 50 marks
Practical
205.1 Laboratory Course (10 marks)
205.2 Field Study and Report Presentation (10 marks)

MSCCONBC206: Chemistry of Biosphere II core 2 credits 50 marks
Practical
206.1 Laboratory Course (10 marks)
206.2 Case Studies and Report Presentation (10 marks)

MSCCONBMIE201: Basic Conservation Biology minor elective 4 credits 50 marks

MSCCONBC201: Core Course

(Chemistry in Natural Management)

(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about waste management and biotic health*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

201.1. **Wastewater Management**: 10.0 Lectures

Characteristics of municipal, domestic and industrial waste water; Principles of toxicity, stabilization, phosphorus removal, oxygen requirement, COD balance, substrate removal efficiency; Collection of waste water, planning for treatment and disposal; Biological treatment methods

201.2 **Solid Waste Management**: 10.0 Lectures

Wastes from mining and metal production; Different types of organic wastes, mixed urban wastes, biomedical wastes, hazardous waste; Management practices of wastes

201.3 **Green Reagents and Green catalysts**: 10.0 Lectures

Use of clayan, dimethyl carbamate, Polymer supported reagents, Biocatalysts, Acid and Basic catalysts, Oxidation catalysts, Photo catalysts, Phase transfer catalysis. Toxicity measures, prevention/minimization of hazardous/toxic products; strengthening/development of analytical techniques

201.4 **Reactions in Green Chemistry and Green Synthesis**: 10.0 Lectures

Microwave assisted reactions, reactions in water, reactions in organic solvent; Ultrasound assisted esterification, saponification, hydrolysis, oxidation, reduction, addition, substitution, alkylation, hydroboration, coupling reaction, photochemical and electrochemical reactions; Synthesis of Epoxy styrene, Ibuprofen and Paracetamol,

201.5 **Biotic Health**: 10.0 Lectures

Radiation toxicology; CO, Microbial toxins; food additives, environmental estrogens and heavy metal toxicity, mutagens, teratogens, risk assessment

Suggested readings:

Wastewater Management: A Guide to Information Sources By George Tchobanoglous, Robert Smith, Ronald W. Crites Published by Gale Research Co., 1976

An Integrated Approach to Wastewater Treatment: Deciding Where, When, and how Much to Invest By Manuel Mariño, John Boland Published by World Bank Publications, 1999

Solid Waste Management: Critical Issues for Developing Countries By Elizabeth M. Thomas-Hope, Elizabeth Thomas, University Press of the West Indies Published by Canoe Press, University of the West Indies, 1998

Solid Waste Management and Recycling: Actors, Partnerships and Policies in Hyderabad, India and Nairobi, Kenya By I. S. A. Baud, Johan Post, Christine Furedy Published by Springer, 2004

Green Chemistry: An Introductory Text By Mike Lancaster, Royal Society of Chemistry (Great Britain) Published by Royal Society of Chemistry, 2002

Introduction to Green Chemistry: Instructional Activities for Introductory Chemistry Published by American Chemical Society, 2002

MSCCONBC202: Core Course

(Biological Rarity Phenomena)

(Credit 4)

Learning Outcome: *At the end of this course the students will have an idea about different population parameters, reproductive strategies and metapopulation*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

202.1 **Rates of Extinction and Forms of Rarity**: 10.0 Lectures

Prehistoric and present rates of species extinction; fossils & prehistoric rates of extinction; prioritizing species for conservation; IUCN categories; prioritizing habitats, conservation areas and selecting reserves.

202.2 **Reproductive Strategies:** 10.0 Lectures

Conventional strategies, artificial insemination, in vitro fertilization, artificial pollination, embryo transfer technology, plant tissue culture, culture of anther, ovule & embryo, artificial seed, cryopreservation of gametes and embryos, genetically modified (GM) seeds & applications; Seed viability & germination (vernalization); Effects Role of photoperiod and temperature on reproduction, and migration.

202.3 **Inbreeding and Outbreeding Depressions:** 10.0 Lectures

Genetics and consequences of inbreeding; Measures of inbreeding; inbreeding depression and extinction; Inbreeding in small populations; Genetic basis of outbreeding depression; Examples of outbreeding depression in animals and plants.

202.4 **Fragmentation and Metapopulation:** 10.0 Lectures

Spatial heterogeneity; Habitat loss and fragmentation; Models of metapopulation growth and extinction

202.5 **Minimum Viable Population and Population Viability Analysis:** 10.0 Lectures

Components of MVP –estimation of parameters; effective population size; modeling risk assessment; sensitivity analysis; implementation, monitoring and evaluation; limits of PVA; Types of extinction

Suggested readings:

Evolutionary Ecology of Plant Reproductive Strategies By Thomas Johannes de Jong, Petrus Gerardus Leonardus Klinkhamer Published by Cambridge University Press, 2005

Comparative Ecology By Yoshiaki Itō, Jiro Kikkawa Published by CUP Archive, 1980

Population Viability Analysis By Steven R. Beissinger, Dale R. McCullough

Contributor Steven R. Beissinger, Dale R. McCullough Published by University of Chicago Press, 2002

Foundations of Restoration Ecology By Donald A. Falk, Margaret A. Palmer, Joy B. Zedler, Society for Ecological Restoration International Contributor Richard J. Hobbs Published by Island Press, 2006

Ecology by Robert E Ricklefs and Gary L Miller published by Macmillan Learning, 2000

MSCCONBC203: Core Course

(Biodiversity Conservation I)

(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about concept, threats and conservation of biodiversity*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

203.1 **Biodiversity: Definition, Concept and Values** 10.0 Lectures

Distribution of biological wealth in our planet, Biodiversity hierarchy; Biogeographical classification of India; Major Pretected areas of India with special emphasis on West Bengal; Consumptive and productive use, Values of biodiversity.

203.2 **Levels of and Threats to Biodiversity:** 10.0 Lectures

Levels at global, regional and local scale; Monitoring & measurement of Biodiversity; indices; Threats like overexploitation, fragmentation, habitat loss, poaching of wildlife, man-wildlife conflicts, natural calamities, effect of degeneration of biodiversity on future of evolution.

203.3 **Hotspots and Megadiversity Countries:** 10.0 Lectures

Criteria for assignment of megadiversity countries and hot spots; India as a mega-diversity region; Flora & fauna of other Megadiversity countries; Hot-spots of biodiversity; Wealth of Indian hot-spots.

203.4 **Endangered and Endemic species of India:** 10.0 Lecture

Scheduled species and their distribution; conservation efforts in Indian flora & fauna - Case studies (Rhino vision 2020, Manipur Deer,; Gyps bengalensis, Great Indian Bustard, Tylototriton, Pygny Hog and Hispid Hare).

203.5 **In-situ and Ex-situ Conservation:** 10.0 Lectures

Concept; captive breeding and case studies of relocation; Plant propagation; Importance of zoos, aquaria, botanical gardens, seed banks, gene banks or germplasm reserves; Habitat conservation.

Suggested readings:

Megadiversity Conservation: Flora, Fauna and Medicinal Plants of India's Hot Spots By AB Chaudhuri, D. D. Sarkar Published by Daya Books, 2004

2000 IUCN Red List of Threatened Species By Craig Hilton-Taylor, Russell A. Mittermeier, International Union for Conservation of Nature and Natural Resources Species Survival Commission, BirdLife International, Conservation International Published by IUCN, 2000

Ex Situ Plant Conservation: Supporting Species Survival in the Wild By Edward O. Guerrant, Kayri Havens, Mike Maunder, Peter H. Raven Published by Island Press, 2004

Medicinal Plants: Rescuing a Global Heritage By John Lambert, Jitendra Srivastava, Noel Vietmeyer Published by World Bank Publications, 1997

MSCCONBC204: Core Course

(Chemistry of Biosphere)

(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about chemistry of biosphere and climate change*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

204.1 **Chemistry in Biosphere Conservation: Global Perspective:** 10.0 Lectures

Role of chemistry in Biosphere conservation; Modern trends in conservation chemistry; Worldwide inter connectedness of the subject; Environmentalism and conservation chemistry; Different Biospheric components.

204.2 **Chemistry of Atmosphere and Global Climate:** 10.0 Lectures

Regions of the atmosphere, chemical composition of the atmosphere, Reactions and calculations in atmospheric chemistry (thermodynamic & kinetic calculations, photochemical reactions, reactions involving free radicals); Formation and turnover of ozone, catalytic decomposition, hydroxyl radical cycle, nitric oxide cycle, chlorine radical cycle; Energy budget, changes in energy system due to external and internal forcing.

204.3 **Chemistry of Hydrosphere:** 10.0 Lectures

The hydrological cycle, main processes in the hydrological cycle; Ground water; Metals in hydrosphere; Two variable diagrams; pE-pH diagrams to describe natural systems, Gases in water, Organic matter in water; Humic material as a complexing agent for the metal ions.

204.4 **Chemistry of Lithosphere:** 10.0 Lectures

Parent materials in development of soil, physical properties, Chemical properties of the soil; Reactions with acids and bases, geochemical reactions, biological reactions; Binding of heavy metals, trace metals in soil.

204.5 **Global Climate Change: Causes and Consequences:** 10.0 Lectures

Climate and other environmental systems; flood, drought, desertification, hail storm, storm surges, coastal erosion, variations in sunspot activity, El Nino events, chemistry of rain, snow and fog formation; Evidences of climate change, historical and geological evidences; External factors of climate change; Global warming, Global dimming

Suggested readings:

Terrestrial Biosphere Exchange with Global Atmospheric Chemistry: Terrestrial Biosphere Perspective of the IGAC Project: Companion to the Dookie Report : Report of the Recommendations from the SCOPE/IGBP Workshop on Trace-Gas Exchange in a Global Perspective, Sigtuna, Sweden, 19-23 February 1990By P A Matson, D S Ojima,

M O Andreae Published by International Council of Scientific Unions, 1990 Environmental Chemistry By Stanley E. Manahan Published by CRC Press, 2005

Global Ecology By Charles H. Southwick Published by Sinauer Associates, 1985 Marine Chemistry: The Structure of Water and the Chemistry of the Hydrosphere By Ralph Albert Horne Published by Wiley-Interscience, 1969

Original from the University of Michigan Fundamental Concepts of Environmental Chemistry By G. S. Sodhi Published by Alpha Science, 2005

Fluorine and the Environment: Atmospheric Chemistry, Emissions & Lithosphere By Alain Tressaud Contributor

PRACTICAL PAPERS
MSCCONBC205:
(Biodiversity Conservation II)
Core Course
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to to learn and perform various abundance estimation techniques (flora and fauna) through various field activities*

Time – 5 hrs **Full Marks: 50**

1. Comparative studies of dentition, skull and horns; Study of campus flora and fauna;
2. Study of nearby forests and grasslands A study of habitat specificity in birds or small mammals on campus
3. Methods of studying diet; examination of scats;
4. Calculations of island biogeography parameters etc.
5. Point count method of density analysis
6. Line transect and belt transect method of community study
7. Nested quadrat analysis and plotless vegetation mapping
8. Field study and report presentation
9. Laboratory note book
10. Viva voce

PRACTICAL PAPERS
MSCCONBC206:
(Chemistry of Biosphere II)
Core Course
(Credit 2)

Learning Outcome: *At the end of this course the students will be learn and perform the methods to collect measure and analyze environmental data related to soil, water, air and productivity*

Time – 5 hrs **Full Marks: 50**

1. Spectrophotometric Analysis of Nitrate, Phosphate, Sulphate, Iron, Chromium
2. Spectrophotometric analysis of chlorophyll from plants.
3. Separation of cations using ion exchange resins;
4. Potentiometric determination of fluoride ion;
5. Select physico-chemical and biological factors of soil, air and water (Soil: water holding capacity; N, P, K; NO_3 – N, NH_4 – N, humic acid, Fulvic acid, total organic carbon any two heavy metals; Air: SPM, RPM, CO, SO_2, NO_2; ambient noise. Water: turbidity, BOD, COD)
6. Determination of Ascorbic acid using iodometric titration
7. Local Industry visit
8. Laboratory note book
9. Viva voce

MSCCONBMIE201: Minor Elective Course

(Basic Conservation Biology)

(Credit 4)

Learning Outcome: *At the end of this course the students will have a basic knowledge on ecosystem, pollution and biodiversity conservation*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

201.1. Abiotic and biotic components of ecosystem; topographic, climatic and edaphic regimes; nutrients and minerals; producers, consumers and decomposers. Functioning of ecosystem: energy flow and nutrient cycles, the establishment of trophic equilibrium; food chains, food webs, tropic levels; autotrophs, heterotrophs.

201.2. Biodiversity at global, regional and local levels. Monitoring & measurement and threats of Biodiversity. India as a mega-diversity nation; flora & fauna of other Megadiversity countries; hot-spots of biodiversity; wealth of Indian hot-spots. Categories of IUCN.

201.3. Diverse uses of bioresources; history of exploitation and causes of overexploitation of bioresources; importance of conservation. Social awareness and social movements concerning conservation issues. Laws related to biodiversity conservation.

201.4. Definition of pollution and contamination , Air, Soil, Water and Noise pollution, Sources and effects of different kinds of pollution, Urban and Indoor pollution, Alternative energy sources, Climate change.

201.5. In-situ and Ex-situ Conservation Concept and practice; captive breeding; plant propagation; re-establishment and relocation, zoos and botanical gardens, conservation of plant diversity in seed banks, gene banks or germplasm reserves, conservation beyond park, sanctuaries & reserves: habitat conservation. Marine Protected areas.

Outline of 3rd Semester Course Contents
Semester-III

MSCCONBC301: Natural Resource Management core 4 credits 50 marks
Theory
301.1 Wildlife Ecotourism (10.0 Lectures)
301.2 Environmental Economics and Impact Assessment (10.0 Lectures)
301.3 Landscape and Restoration Ecology (10.0 Lectures)
301.4 Ecosystems and social issues (10.0 Lectures)
301.5 Biodiversity Protection Laws: National Legislations (10.0 Lectures)

MSCCONBC302: Wildlife Management core 4 credits 50 marks
Theory
302.1 Wildlife Health (10.0 Lectures)
302.2 Handling of Wild flora and fauna (10.0 Lectures)
302.3 Captive Breeding and Wildlife Utilizations (10.0 Lectures)
302.4 Natural Disasters and Disaster Management (10.0 Lectures)
302.5 Park and Corridor Designs and Management (10.0 Lectures)

MSCCONBC303: Quantification Techniques I core 4 credits 50 marks
Theory
303.1 Biological sampling and census techniques and application (10.0 Lectures)
303.2 Quantitative Methods in Population studies (10.0 Lectures)
303.3 Biostatistical analysis: (10.0 Lectures)
303.4 Census analysis (10.0 Lectures)
303.5 Simulation models in conservation decisions (10.0 Lectures)

MSCCONBC304: Quantification Techniques II core 2 credits 50 marks
Practical
304.1Laboratory Course (10 marks)
304.2Field Study and Report Presentation (10 marks)

Major Elective Theory and its corresponding Practical:- (Any one)

MSCCONBMJE301	**Forest Wealth - I**	Theory	Major Elective (Option A)	4 credits 50 marks
MSCCONBMJE302	**Forest Wealth - II**	Practical	Major Elective (Option A)	2 credits 50 marks
MSCCONBMJE303	**Wetland Conservation - I**	Theory	Major Elective (Option B)	4 credits 50 marks
MSCCONBMJE304	**Wetland Conservation– II**	Practical	Major Elective (Option B)	2 credits 50 marks
MSCCONBMJE305	**Conservation Genetics - I**	Theory	Major Elective (Option C)	4 credits 50 marks
MSCCONBMJE306	**Conservation Genetics - II**	Practical	Major Elective (Option C)	2 credits 50 marks
MSCCONBMJE307	**Marine Bioresources- I**	Theory	Major Elective (Option D)	4 credits 50 marks
MSCCONBMJE308	**Marine Bioresources- II**	Practical	Major Elective (Option D)	2 credits 50 marks

Minor Elective:
MSCCONBMIE301 Conservation Law and Management Minor Elective 4 credits 50 marks
Theory
301.1 Ecosystems and social issues: (10 Lectures)
301.2 Biodiversity Protection Laws: National legislations: (10 Lectures)
301.3 Natural Disasters and Disaster Management: (10 Lectures)
301.4 Park and Corridor Designs and Management: (10 Lectures)

MSCCONBC301: Core Course

Natural Resource Management

(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about environmental management, laws and ethics*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each,are to be answered

301.1 ***Wildlife Ecotourism*** (10 Lectures)

Wildlife Tourism - objectives, planning; ecotourism in Indian context. Eco tourism in Protected areas of India ans its planning; visitor management in ecotourism areas - zoning, carrying capacity; Participation of local people in ecotourism; ecotourism in practice in important PA's of India – case studies of Periyar Tiger Reserve, Keoladlo National Park, Kanha National Park, Jim Corbet National Park and Sunderbans Tiger Reserve; limitations and problems of ecotourism Ethics in Field Studies

301.2 ***Environmental economics and Impact Assessment***: (10 Lectures)

Introduction to Environmental Impact Assessment (EIA), Environmental Impact Analysis, Social Impact Assessment (SIA), Strategies Environmental Assessment (SEA), Environmental Impact Statement (EIS).-Scope and purpose of EIA: environmental impacts linked to various stages of development projects, contents of an ideal EIA, current state of EIA in India; EIA Notification 2007. ISO system and certification processes.

Environmental Economics: Concept and principles of ecological and environmental economics; cost-benefit analysis, environmental economics for determination of monetary values of environmental goods and services; introduction to some recent approaches in polluters pay principles, precautionary ans compensation principles, trade and ecological economics, externalities.

301.3 ***Landscape and Restoration Ecology***: (10 Lectures)

Introduction and philosophy of restoration; ecological view of recovery; approaches to restoration. Role of ecological restoration in conservation; guidelines for ecorestorations and case study (like mangrove restoration); bioremediation of oil spilled shore line, restoration of open cast mining sites and over burden dumps, displacement and resettlement of local communities with respect to creation of Protected Areas; village translocation from core area.

301.4 ***Ecosystems and social issues***: (10 Lectures)

People's resistances against environmental onslaught-case studies (Chipko movements, Seed movements, Narmada BachavoAandholan, Pani Panchayats,); role of NGOs in conservation efforts; land ethic; community diversity resources use and management; importance of gender based role; participatory learning methods; conflict management, and processes used in conflict resolution; East Calcutta Wetland Ecosystem (Ramsar Site NO.1208) and Social Issues – Case Study.

301.5 ***Biodiversity Protection Laws: National legislations:*** (10 Lectures)

Provisions in constitution of India regarding environment (article 48A and 58A); legislation restricting hunting, killing or overexploitation, legislation for protection of wildlife: Wildlife Protection Acts and amendments. Biodiversity Act 2002. Acts, rules and their amendments: Wildlife Protection Act, 1972; Forest (Conservation) Act, 1980; Indian Forest Act (RevisED)1982;THE Scheduled Tribes and other Traditional Forest Dwellers

(Recognition and Forest Rights) Act, 2006; National Green Tribunal Act, 2010; legislation for protection of marine environment; International conservation related conventions/treaties. Wetlands laws and acts, Concept, power and functions of Green Benches in Indian environmental laws; Eco-Sensitive Zones; legislation for protection of marine environment.

Suggested readings:

J. Glasson, R. Therivel and Andrew Chadwick. Introduction to Environmental Impact Assessment: Principles And Procedures, Process, Practice And Prospects. Taylor and Francis, 2005.
Bram F. Noble. Introduction to Environmental Impact Assessment: A Guide to Principles and Practice Oxford University Press, 2005
John A. Wiens, Michael R. Moss Issues and Perspectives in Landscape Ecology Cambridge University Press, 2005
JalaMakhzoumi, Gloria Pungetti Ecological Landscape Design and Planning: The Mediterranean Context Taylor and Francis, 1999
Celeste M. Brody, James Wallace Contributor Celeste M. Brody Ethical and Social Issues in Professional Education SUNY Press, 1994
Fred Luthans, Richard M. Hodgetts Social Issues in Business: Poverty, Civil Rights, Ecology, and Consumerism Macmillan Co., 1971
Original from the University of Virginia Digitized Oct 1, 2008
Protected Areas of the World: A Review of National Systems By World Conservation Monitoring Centre, IUCN Commission on National Parks and Protected Areas, International Union for Conservation of Nature and Natural Resources, British Petroleum Company Contributor British Petroleum Company
IUCN, 1992
Aparna Sawhney The New Face of Environmental Management in India Ashgate Publishing, Ltd., 2004

MSCCONBC302: Core Course
Wildlife Management
(Credits 4)

Learning Outcome: *At the end of this course the students will have an idea about tools and techniques of wildlife management*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, two questions (out of four) of 8 mark each, and are to be answered

302.1 ***Wildlife Health***: (10 Lectures) Defense mechanism of plants and animals (immune system); review of major viral, bacterial, protozoan, fungal and parasitic diseases of Indian wild mammals, birds, amphibians and reptiles; determinants of disease and disease transmission, disease and population dynamics. *Ex-situ/in situ* Health check-up schedule.

302.2 ***Handling of Wild flora and fauna***: (10 Lectures)
Capture and Animals Barriers: Purposes, live traps, snares, pits, nets, canon (rocket) nets, net gun, mist nets, corrals, stockade, spotlighting. Animal barriers: Reasons for use; trenches, walls, stockades, mechanical fences, electric fences, repellents. Drug immobilization- Drug action, dosages, responses, side effects, safety measures of tranquilization, complications. : Jab stick, blowpipe, pistol, rifle, crossbow, dart design; radio darts. Handling and transport, design of sledge, crate and holding enclosures. Purposes, identification by natural marking, individual damage; behavioral idiosyncrasies etc., passive marking collars, tags, branding, rings etc. Dynamic marking-beta light, radio-tracking-harnesses, collars; telemetering of physiological parameters etc.

302.3 ***Captive Breeding and Wildlife Utilizations***: (10 Lectures)

Case studies on conservation breeding programs: Red Panda, Crocodiles, Olive Ridley, Batagur bask, Bengal vulture. Illegal trade of wild flora and fauna.

302.4 ***Natural Disasters and Disaster Management***: (10 Lectures)
Disasters – definition, categories, preparedness, prevention and management with special reference to coastal disasters (due to erosion, tsunami and cyclone); landslide and avalanches; forest fire (natural and man-made). Quantitative Risk Assessment in Disasters. Control of coastal erosion and coastal flooding. Law for disaster management

302.5 ***Park and Corridor Designs and Management***: (10 Lectures)
Classification and functions of ecological Corridors, ecological corridor and habitat conservation, Movements of Animals through corridor linkages, Peninsula Effects. Corridor design. Case study (Elephant corridor, Tiger corridor, Rhino corridor).

Suggested readings:

Livestock By National Research Council (U.S.). Committee on Managing Global Genetic Resources: Agricultural Imperatives National Academies Press, 1993

SantiagoCarrizosa Accessing Biodiversity and Sharing the Benefits: Lessons from Implementing the Convention on Biological Diversity International Union for Conservation of Nature and Natural Resources, Stephen B. Brush, IUCN Brian D. Wright, Patrick McGuire Environmental Law Programme, IUCN Patrick McGuire Genetic Resources Conservation Program Contributor IUCN, 2004

Timothy M. Swanson, Edward Barbier Economics for the Wilds: Wildlife, Diversity, and Development Island Press, 1992

Damon P. Coppola Introduction to International Disaster Management Butterworth-Heinemann, 2006

Harsh K. Gupta Disaster Management, Indian National Science Academy Orient Blackswan, 2003

Jodi A. Hilty, William Zander Lidicker, Adina Maya Merenlender, Andrew P. Dobson Corridor Ecology: The Science and Practice of Linking Landscapes for Biodiversity Conservation Island Press, 2006 John Tillman Design for human ecosystems Island Press, 1999

MSCCONBC303: Core Course
(Quantification Techniques I)
(Credits 4)

Learning Outcome: *At the end of this course the students will be able to learn about quantification techniques in population studies and bio-statistical analysis*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, two questions (out of four) of 8 mark each, and are to be answered

303.1 ***Biological sampling and census techniques and application***: (10 Lectures)
Sampling vs census; resampling methods; habitat specific sampling methods; census techniques – point, strip and line transects, call-counts, pellet group-counts, scat/signs survey; radio-telemetry; measurements of association. King census. Remote sensing in flora-faunal census. Prey base and trapping census.

303.2 ***Quantitative Methods in Population studies***: (10 Lectures)
Basic mathematics for ecologists. Role of statistics in science and the scientific method. Overview of sampling and experimental design. Exploratory data analysis. Probability theory. Concepts of a random variable: discrete and continuous, expected value and variance. Central tendencies, Probability distributions and densities; binomial, Poisson, normal distributions. Joint distribution of two variables, covariance.

303.3 ***Biostatistical analysis***: (10 Lectures)
Hypothesis Testing, Regression and correlation, tests for significance: Pearsonian, Chi Square, t-test, ANOVA.

303.4 ***Census analysis***: (10 Lectures) Analysis of census data (studies of various population parameters and use of census techniques will be carried out as part of field exercises).

303.5 ***Simulation models in conservation decisions***: (10 Lectures)
Basic Concepts of simulation models in ecology; uncertainty and sustainability; detection of environmental uncertainty; sustainable catch; sustainable use.

Suggested readings:

Ecological Census Techniques: A Handbook William J. Sutherland Contributor William J. Sutherland CambridgeUniversity Press, 2006
Introduction to Distance Sampling: Estimating Abundance of Biological Populations Stephen T. Buckland, D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, Len Thomas Oxford University Press, 2001
Designing Field Studies for Biodiversity Conservation: The Nature Conservancy Peter Feinsinger Island Press, 2001
The Ecological Economics of Biodiversity: Methods and Policy Applications Paulo Augusto Lourenço Dias NunesNunes, Jeroen C. J. M. van den Bergh, Peter Nijkamp Edward Elgar Publishing, 2003
Community Structure and Analysis Marvin B. Sussman Crowell, 1971
Community Structure and Analysis Marvin B Sussman University Microfilms, 1971
A Simulation Model for Decision Making in Soil Conservation: School of Development Studies, 1994 Decision Methods for Forest Resource Management Joseph Buongiorno, J. Keith Gilless Academic Press, 2003 Applied Multivariate Statistical Analysis, Richard Arnold Johnson, Dean W. Wichern, Prentice Hall, 2007
Applied Multivariate Statistical Analysis (2nd ed.), Richard A. Johnson and Dean W. Wichern, Englewood Cliffs, NJ: Prentice-Hall, 1988,
Introduction to Multivariate Analysis, Christopher Chatfield, Alexander J. Collins CRC Press Spatial Cluster Modelling Andrew B. Lawson, David G. T. Denison CRC Press,2002

MSCCONBC304 : Core Course (General Practical)

Quantification Techniques II

(Credit Points 2)

Learning Outcome: *At the end of this course the students will be able to identify, monitor and measure different flora and fauna*

Time – 5 hrs **Full Marks: 50**

304.1: ***General Laboratory Course***: (10 marks)
1. Measuring height and crown diameter of tree;
2. *ad libitum* observations and preparation of ethograms field
3. Identification of natural markings and animal droppings
4. Demonstration of equipments and use tags, collars, radio tracking equipment and bird ringing.

304.2 ***Field Study and Report Presentation*** (10 marks)
Livelihood dependency on wetland/forest/local sanctuary

Major Elective

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 mark each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

MSCCONBMJE 301:
(Forest Wealth – I)
(Credit Points 4)

Learning Outcome: *At the end of this course the students will be able to learn about basic plant taxonomy and forest management*

301.1(FW) ***Introduction to Forestry***: (10 Lectures)

Forest types (Champion and Seth's classification): tropical evergreen forest, moist deciduous forest, dry/temperate deciduous forest, thorn forest, litoral/tidal forest, tropical/subtropical savannah, tropical desert, evergreen coniferous forest, west temperate forests, alpine vegetation, concept of and management of forests in India. Changing perspectives of forest management. National forest policy.

301.2(FW) ***Silviculture and Forest Ecology***: (10 Lectures)

Basic concepts; role of silviculture and forest ecology; silvicultural systems; concept of sustainability; social forestry, agroforestry, biofertilizer, green manuring, vermicomposting, phytoremediation

301.3(FW) ***Autecology of Tree Development***: (10 Lectures)

The autecology of tree development (tree classifications; stem cambium development and wood properties; shoot and crown development; root development; flowering, fruiting, seed production, and vegetative propagation), Anomalous secondary growth.

301.4(FW) ***Synecology of Stand Development***: (10 Lectures)

Forest site considerations in synecology (effects of climate, landform, and soil on site suitability; site quality; site classification; site vulnerability). The synecology of stand development and production ecology (vegetative description of stands; transfer and storage of energy; Tree Improvement Programmes.

301.5(FW) ***Plant – Animal Interactions***: (10 Lectures)

Insects as pests, Insect functional feeding groups; evolution of plant and animal defences against each other; mammalian herbivores and their feeding. Pollination and seed dispersal by animals.plant chemicals and insect metabolism, ecology of host and pest,ant-guard system; biological control and plant derived insecticides.

Suggested readings:

An Introduction to Forestry Luther R. Hilterbrand Balt, 1967
The Practice of Silviculture: Applied Forest Ecology David M. Smith, Bruce C. Larson, P. Mark S. Ashton, Matthew J. Kelty Wiley, 1996
Forest Ecology, the Biological Basis of Silviculture: The Biological Basis of Silviculture Harold John Lutz University of British Columbia, 1959
Nonequilibrium Ecology Klaus Rohde CambridgeUniversity Press, 2005
Ecology of a Managed Terrestrial Landscape: Patterns and Processes of Forest Landscapes in Ontario Ajith Perera, Dave Euler, Ian Thompson University of British Columbia Press, 2001
Plant Communities: A Textbook of Plant Synecology Rexford F. Daubenmire Harper and Row, 1968
Plant-animal Interactions: Evolutionary Ecology in Tropical and Temperate Regions Peter W. Price J. Wiley, 1991
Plant-animal Interactions: An Evolutionary Approach Carlos M. Herrera, OllePellmyr Blackwell Publishing, 2002

MSCCONBMJE302
(Forest Wealth II)
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to perform experiments related to forest wealth characterization in field and laboratory*

Time – 5 hrs **Full Marks: 50**

Vegetation mapping; comparison of litter-fall; identification of silviculturally important tree species. Identification of important medicinal and weed species; plant-animal interactions; chlorophyll and ascorbic acid determination of plant; species importance value index (IVI).

MSCCONBMJE303
Wetland Conservation – I
(Credit Points 4)

Learning Outcome: *At the end of this course the students will have an overview about types and characteristics of wetland ecosystem*

303.1(WC) ***Overview of wetland types and distribution***: (10 Lectures)
Definitions, distributions, causal factors, zonations, functions.

303.2(WC) ***Extent of wetland changes and impacts in India***: (10 Lectures)
Major wetlands of India, types and locations, wetland classification system in India; major threats.

303.3(WC) ***Hydroperiod, Water budget, Groundwater and tides***: (10 Lectures)
Geomorphologic features and hydrological status of major Indian wetlands, tides and coastal flood-plains, consequences of altered hydrology, reasons, models on hydrology, effects of burial, rates of sedimentation, groundwater replenishment. Salinity in wetlands- sources distribution of major ions and effect on biota

303.4(WC) ***Wetland Characters and Productivity***: (10 Lectures)
Land-water interfaces, aquatic macrophytes in wetland; macrophyte characteristics. Primary productivity of macrophytes. Primary and secondary productivity of different types of Indian major wetlands, factors affecting productivity, major pollutants and reasons for eutropohications, consequences of eutrophications.

303.5(WC) ***Chemical transformations in wetlands***: (10 Lectures)
Chemistry of wetland water and soil, partitioning and nutrient cycling processes, allochthonous and autochthonous inputs and transformations, heavy metals and toxicants in wetlands.

Suggested readings:

Wetland Indicators: A Guide to Wetland Indentification, Delineation, Classification, and Mapping Ralph W. Tiner CRC Press, 1999
Wetlands Through Time Stephen F. Greb, William A. DiMichele Geological Society of America, 2006
Climate Change and India: Vulnerability Assessment and Adaptation P. R. Shukla Orient Blackswan, 2003 Wetlands William J. Mitsch, James G. Gosselink John Wiley and Sons, 2007 Global Wetlands: Old World and New William J. Mitsch Elsevier, 1994

MSCCONBMJE304
Wetland Conservation II
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to perform experiments related to wetland characteristics through field and laboratory studies*

Time – 5 hrs **Full Marks: 50**

Physico-chemical conditions of soil: moisture content, water holding capacity; N, P, K; NO_3 – N, NH_4 – N, identification of wetland biota; measurement of productivity.

MSCCONBMJE305
Conservation Genetics – I
(Credit Points 4)

Learning Outcome: *At the end of this course the students will be able to learn about evolution and characterization of genetic diversity and population genetics*

305.1(CG) ***Characterizing genetic diversity***: (10 Lectures)
Basis, importance, organization and properties of quantitative genetic variations; genotype-environment interactions; evolutionary potential and heritability.

305.2(CG) ***Maintenance and Evolution of genetic diversity***: (10 Lectures)
Evolution in large population; natural selection and adaptation; mutations, migration and their interaction with selection; evolution in small population; maintenance of genetic diversity.

305.3(CG) ***Population fragmentation and loss of genetic diversity***: (10 Lectures)
Genetic management of fragmented population; introgression and hybridization; impacts of hybridization; genetic issues in reserve design; importance of corridors.

305.4(CG) ***Metapopulation dynamics***: (10 Lectures) Metapopulation definitions and models; influence of patch size and distances; impact of metapopulation on reproductive fitness.

305.5(CG) ***Genetically viable populations***: (10 Lectures)
Causes of endangerment and extinction; predicting extinction probabilities; Population Viability Analysis (PVA); Minimum Viable Population (MVP) and recovering threatened populations.

Suggested readings:

Conservation Genetics Volker Loeschcke, Jürgen Tomiuk, Subodh K. Jain Birkhäuser, 1994
A Primer of Conservation Genetics Richard Frankham, Jonathan D. Ballou, David Anthony Briscoe, Karina H. McInnes Cambridge University Press, 2004
A Primer of Conservation Genetics Richard Frankham, Jonathan D. Ballou, David Anthony Briscoe, KarinaH.McInnesCambridgeUniversity Press, 2004
Introduction to Conservation Genetics: Richard Frankham, Jonathan D. Ballou and David A. Briscoe Richard Frankham, David Anthony Briscoe, Jonathan D. Ballou, Karina H. CambridgeUniversity Press, 2002
Evolutionary Genetics: Concepts and Case Studies Charles W. Fox, Jason B. Wolf Contributor Charles W. Fox, Jason B. Wolf OxfordUniversity Press US, 2006
Plant Conservation Genetics Robert J. Henry Haworth Press, 2006
Conservation Genetics: Case Histories from Nature John C. Avise, James Lewis Hamrick Springer, 1995

MSCCONBMJE306
(Conservation Genetics II)
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to will be able to perform DNA isolation techniques and population genetics experiments*

Time – 5 hrs **Full Marks: 50**

Studies on serum protein; DNA isolation from animal remains/droppings; population genetics experiments.

MSCCONBMJE307
Marine Bioresources - I
(Credit Points 4)

Learning Outcome: *At the end of this course the students will be able to learn about marine ecosystem characteristics, resources and threats*

307.1(MB) ***Marine Resources of India: an Overview***: (10 Lectures)
Vastness and richness of coastline of India; major resources and zones of rich diversity; economic return; biomedical and industrial use of marine Bioresources; reasons for coastal, open and deep sea Bioresources depletion.

307.2(MB) ***Zonations and Climatic Features***: (10 Lectures)
Marine zonations; macro- and micro-climatic features of marine environment; ocean floor and tectonic plate movements, impact of sea-floor spreading; major types of waves and tides and their impact of marine fauna; impact of pressure on fauna.

307.3(MB) ***Ocean Circulations and Waves***: (10 Lectures)
Major oceanic currents and impact; drive for currents; reasons and impact of down welling and upwelling; relation between ocean circulations, primary productivity and chemical composition of atmosphere and ocean.

307.4(MB) ***Chemistry of Sea-Water***: (10 Lectures)
Major and minor constituents of sea-water and their residence time; chemical compositions-control processes; sources and sinks of dissolved gases in sea water; heterogeneity in chemical compositions and flora-faunal distribution.

307.5(MB) ***Marine Pollution***: (10 Lectures)
Overview of sources and fate of pollutants; major dumping issues; perils of oil-spill; marine pollution and global climate changes.

Suggested readings:

The ImprovingState of the World: Why We're Living Longer, Healthier, More Comfortable Lives on a Cleaner Planet ByIndur M. Goklany Cato Institute, 2007
Terra Non Firma Earth James Maxlow One Off Publishing, 2005
Ocean Circulation Theory Springer, 1996
The Oceans: Their Physics, Chemistry, and General Biology HaraldUlrik Sverdrup, Martin Wiggo Johnson, Richard Howell Fleming Published by Prentice-Hall, inc., 1942

MSCCONBMJE308

(Marine Bioresources II)

(Credit 2)

Learning Outcome: *At the end of this course the students will be able to identify marine biota and perform analytical techniques of sea water*

Time – 5 hrs **Full Marks: 50**

Physico-chemical conditions of marine water and sediment; studies on marine plankton; identification of coastal flora-fauna of India.

MSCCONBMIE301: Minor Elective
Conservation Law and Management
(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about social issues, disaster management and biodiversity legislations*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

301.1 **Ecosystems and social issues:** (10 Lectures)
People's resistances against environmental onslaught-case studies (Chipko movements, Seed movements, Narmada BachavoAandholan, Pani Panchayats,); role of NGOs in conservation efforts; land ethic; community diversity resources use and management; importance of gender based role; participatory learning methods; conflict management, and processes used in conflict resolution; East Calcutta Wetland Ecosystem (Ramsar Site No.1208) and Social Issues – Case Study. Wildlife conservation initiatives.

301.2 **Biodiversity Protection Laws: National legislations:** (10 Lectures)
Provisions in constitution of India regarding environment (article 48A and 58A); legislation restricting hunting, killing or overexploitation, legislation for protection of wildlife: Wildlife Protection Acts and amendments. Biodiversity Act 2002. Acts, rules and their amendments: Wildlife Protection Act, 1972; Forest (Conservation) Act, 1980; Indian Forest Act (Revised)1982;The Scheduled Tribes and other Traditional Forest Dwellers (Recognition and Forest Rights) Act, 2006; National Green Tribunal Act, 2010; legislation for protection of marine environment; International conservation related conventions/treaties. Wetlands laws and acts, Concept, power and functions of Green Benches in Indian environmental laws; Eco-Sensitive Zones; legislation for protection of marine environment.

301.3 **Natural Disasters and Disaster Management**: (10 Lectures)
Disasters – definition, categories, preparedness, prevention and management with special reference to coastal disasters (due to erosion, tsunami and cyclone); landslide and avalanches; forest fire (natural and man-made). Quantitative Risk Assessment in Disasters; Control of coastal erosion and coastal flooding; Law for disaster management

301.4 **Park and Corridor Designs and Management**: (10 Lectures)
Classification and functions of ecological Corridors; ecological corridor and habitat conservation; movements of animals through corridor linkages; Peninsula Effects Corridor design; Case study (Elephant corridor, Tiger corridor, Rhino corridor)

Suggested readings:

Varieties of Environmentalism: Essays North and South, Ramachandra Guha and Joan Martínez Alier, Earthscan Ltd, 1997;

Existing and Potential Ramsar Sites of India (Bombay Natural History Society), *BNHS, AsadRahmani, et al., 2008;*
Handbook of Environmental Law in India, *P.B. Sahasranaman* , *OUP India , 2009;*
Vulnerable India: A Geographical Study of Disasters, Anu Kapur, Sage India,2010;
Natural Hazards and Disaster Management: Vulnerability and Mitigation, R.B. Singh, Rawat Publications, 2006;
Wonders of the Indian Wilderness 3 Vol. Set; The Nature of Biodiversity in India, National Parks and Wildlife Sanctuaries of India , a History of Nature Conservation in India, ErachBharucha , *Mapin, 2006;*
Wildlife Tourism and Conservation, Vivek Saharan , *Random Publications , 2016.*

Outline of 4th Semester Course Contents
Semester-IV

MSCCONBC401: Bioinformatics and Computer Application core 4 credits 50 marks
Theory

401.1 Principle of Bioinformatics: (10.0 Lectures)
401.2 Nucleic acid and protein sequence databases: (10.0 Lectures)
401.3 Internet Databases and Data Retrieval: (10.0 Lectures)
401.4 Phylogenetic analyses and Predictive Methods (10.0 Lectures)

MSCCONBC402 : Biostatistics And Bioinstrumentation core 4 credits 50 marks
Theory :
402.1 Multivariate Analysis: (10.0 Lectures)
402.2 Measures of central tendency and dispersal: (10.0 Lectures)
402.3 Distribution: (10.0 Lectures)
402.4 Principles of analytical methods: (10.0 Lectures)
402.5 Analysis of biomolecules (10.0 Lectures)

MSCCONBC403: Dissertation core 4 credits 50 marks
Practical
403.1 Dissertation Report and presentation

MSCCONBC404: Bioinformatics, Biostatistics and Computer Applications core 2 credits 50 marks
Practical

Major Elective

Any One Theory and its corresponding Practical from (Continued from Semester III):-

MSCCONBMJE401	**Forest Wealth - III**	Theory	Major Elective (Option A)	4 credits 50 marks
MSCCONBMJE402	**Forest Wealth - IV**	Practical	Major Elective (Option A)	2 credits 50 marks
MSCCONBMJE403	**Wetland Conservation - III**	Theory	Major Elective (Option B)	4 credits 50 marks
MSCCONBMJE404	**Wetland Conservation– IV**	Practical	Major Elective (Option B)	2 credits 50 marks
MSCCONBMJE405	**Conservation Genetics - III**	Theory	Major Elective (Option C)	4 credits 50 marks
MSCCONBMJE406	**Conservation Genetics - IV**	Practical	Major Elective (Option C)	2 credits 50 marks
MSCCONBMJE407	**Marine Bioresources- III**	Theory	Major Elective (Option D)	4 credits 50 marks
MSCCONBMJE408	**Marine Bioresources- IV**	Practical	Major Elective (Option D)	2 credits 50 marks

SEMESTER -IV

MSCCONBC401 : Core Course
Bioinformatics and Computer Application
(Credit 4)

Learning Outcome: *At the end of this course the students will be able to learn about different tools and techniques of bioinformatics and computer applications*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each are to be answered

401.1 ***Principle of Bioinformatics***: (10.0 Lectures)
Scope of bioinformatics; data acquisition; sequencing DNA, RNA and protein; determination of protein structure; gene–protein expression data; protein interaction data.

401.2 ***Nucleic acid and protein sequence databases***: (10.0 Lectures)
Data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation.

401.3 ***Internet Databases and Data Retrieval***: (10.0 Lectures)
Databases – contents, structure and annotation; retrieval of biological data; searching sequence databases; multiple sequence alignment; structural bioinformatics; computing in bioinformatics.

401.4 ***Phylogenetic analyses and Predictive Methods***: (10.0 Lectures)
Phylogenetics; cladistics and ontology; building phylogenetic trees; evolution of macromolecular sequences; sequence annotation; microarray and proteomic data analysis.

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Suggested readings:
Applied Multivariate Statistical Analysis, Richard Arnold Johnson, Dean W. Wichern, Prentice Hall, 2007
Applied Multivariate Statistical Analysis (2nd ed.), Richard A. Johnson and Dean W. Wichern, Englewood Cliffs, NJ: Prentice-Hall, 1988,
Introduction to Multivariate Analysis, Christopher Chatfield, Alexander J. Collins CRC Press Bioinformatics: Sequence and Genome Analysis, David W. Mount CSHL Press, 2004 Spatial Cluster Modelling Andrew B. Lawson, David G. T. Denison CRC Press, 2002 Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins Andreas D. Baxevanis, B. F. Francis Ouellette Wiley, 2005
Molecular Evolution a Phylogenetic Approach Roderic D M Page, Edward C Holmes, Blackwell Publishing, 1998

MSCCONBC402 : Core Course
BIOSTATISTICS AND BIOINSTRUMENTATION
(Credit 4)

Learning Outcome: *At the end of this course the students will have an idea about biostatistics and different molecular techniques*

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

402.1 ***Multivariate Analysis***: (10.0 Lectures)
Introduction to Multivariate statistics: test of hypothesis and significance. Multiple regression, Multiple Logistic Regression, Principal Component Analysis, Cluster Analysis

402.2 ***Measures of central tendency and dispersal***: (10.0 Lectures)
Non-parametric statistics: confidence interval; errors; levels of significance; regression and correlation;

402.3 ***Principles of analytical methods***: (10.0 Lectures)
Titrimetry, gravimetry, colorimetry, UV/Visible spectrophotometry, chromatography, AAS, GLC, HPLC, Electrophoresis, X-ray fluorescence, flame photometry.

402.4 ***Microscopic Techniques***: (10.0 Lectures)
Light microscopy, electron and fluorescence microscopes, sample analysis techniques.

402.5 ***Analysis of biomolecules*** (10.0 Lectures)
Using fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods

MSCCONBC403: Core Course
Dissertation
(Credit 4)
NOTIONAL HOURS : 100

Learning Outcome: *At the end of this course the students this course the students will be able to learn how to design, perform and report works of original research work in the field of conservation biology.*

403.1: **Dissertation Report** on field based study for a duration of at least 3 months; 30 marks internal, 10 marks for preparation & 10 marks for presentation & discussion.

MSCCONBC404: Core Course
(Bioinformatics, Biostatistics and Computer Applications)
(General Practical - 5)
(Credit 2)

Learning Outcome: *At the end of this course the students this course the students will learn how to use different software in bioinformatics, biostatistics and population studies*

Time – 5 hrs **Full Marks: 50**

404.1 **: General Practical**

1 Graphical representations using MS Excel, SPSS and Statistica

2 Data analyses using SPSS, PAST and R.
3. Use of diversity analyses software name a few: STELLA, RAMAS ECOLAB, GAPPS, DISTANCE
4. Use of internet data base for Bioinformatic studies.
5. Open source GIS software to represent plant diversity-tree and plant identification.

404.2 : Lab visit of a microscopic techniques/molecular biology/ bioinformatics /PCR / Electrophoresis techniques.

Major Elective
(Credit 4)

Time: 2 hrs **Full Marks: 50**

Eight questions (out of twelve) of 1 marks each, four questions (out of eight) of 4 marks each, and two questions (out of four) of 8 mark each, are to be answered

MSCCONBMJE401
Forest Wealth – III
(Credit Points 4)

Learning Outcome: *At the end of this course the students will be able to learn about faunal wealth of forests*

401.1(FW) ***Forest Entomology***: (10.0 Lectures)
Insect taxonomy and diversity. Their living and non-living environment, economic importance, ecological roles, adaptation, Insects as indicator for biodiversity monitoring. Diversity patterns across biogeographic zones. Insect fauna in India. Specific case studies on forest infestation by sal borer and a few forest pests and their life cycle and management.

401.2(FW) ***Forest Microbiology***: (10.0 Lectures)
Rhizosphere and rhizoplane microorganisms; Effect of organic matter decomposition on microbial growth, microbial biomass as index of soil fertility, microbes of soil, aeromicrobiology, phylloplane microflora, microbial interaction on leaf surfaces, nitrogen fixation, bioremediation, bioleaching, biopesticide, biosensors.

401.3 (FW)***Herpetology***: (10.0 Lectures)
Systematic and zoogeography of amphibians and reptiles in India: Biology of major Indian amphibians, fresh water and marine turtles, crocodilians, lizards and snakes. Role of environmental factors in sex determination. An overview of conservation problems and issues of herpetofauna of Indian sub-continent. Case studies.

401.4 (FW) ***Ornithology***: (10.0 Lectures)
Avian systematics; Sexual selection in birds. Birds' migration: Migratory flyways, threats to migrant populations. Avian community ecology and habitat selection. Endangered and threatened birds; waterfowls, pheasants, bustards & floricans, cranes, waterfowls, raptors. Conservation of birds habitats.

401.5 (FW) ***Mammalogy***: (10.0 Lectures)
Mammalian characteristics, anatomy and skeleton. Evolution of mammals, early radiation and classifications up to orders. Adaptation in mammals-hibernation, torpor, aestivation, locomotion and water regulation. Metabolism and thermo-regulation; Biology of some threatened mammals.
Suggested readings:

Ornithology Frank B. Gill W. H. Freeman & Company, 2006
Ornithology: An Introduction Austin Loomer Rand Norton, 1967
The Birds of India: Thomas ClaverhillJerdon Printed for the Author by the Military Orphan Press, 1864
Mammal Species of the World: A Taxonomic and Geographic Reference Don E. Wilson, DeeAnn M. Reeder JHU Press, 2005
Mammal Species of the World: A Taxonomic and Geographic Reference Don E. Wilson, DeeAnn M. Reeder JHU Press, 2005
Recent Advances in Ecobiological Research Manoranjan P. Sinha, P. N. Mehrotra APH Publishing, 1997 Forest Entomology: Ecology and Management Robert Norris Coulson, John A. Witter Wiley-IEEE,

1984 Forest Entomology Samuel Alexander Graham McGraw-Hill, 1952 Forest Entomology L K Jha, P K Sen-Sarma APH Publishing, 2008
Original from the University of Michigan Microbiology and Biogeochemistry of Hypersaline Environments: Microbiology and Biogeochemistry of Aharon Oren CRC Press, 1998
Microbiology of Tropical Soils and Plant Productivity Yvon R. Dommergues, H. G. Diem Springer, 1982 The Zoological Record By Zoological Society of London, Zoological Record Association (London, England), Cambridge Scientific Abstracts, Inc Internet Database Service J.V. Voorst, 1971 Annual Report on the Zoological Survey of India By Zoological Survey of India, Zoological Survey of India Published by Manager of Publications, Civil Lines, 1985
The Biology of Hypogean Fishes Aldemaro Romero, Aldemaro Romero Díaz Contributor Aldemaro Romero Díaz Springer, 2002
Oceanographic Literature Review Pergamon Press, 1996 Item notes: v.43 pp.961-1576 1996
The Freshwater Fishes of India, Pakistan, Bangladesh, Burma, and Sri Lanka: Handbook K. C. Jayaram, B. K. Tikader The Survey, 1981

Major Elective Practical
MSCCONBMJE402
(Forest Wealth – IV)
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to identify and characterize forest fauna*

Time – 5 hrs **Full Marks: 50**

402.1(FW) Faunal habitat mapping; physico-chemical & biological characteristics of forest floor & soil; identification of important endemic species; identification of important threatened species; identification of parasites of forest trees and wild fauna; cost determination.

MSCCONBMJE403
Wetland Conservation – III
(Credit Points 4)

Learning Outcome: *At the end of this course the students will have an overview about threats and management of wetland ecosystem*

403.1(WC) ***Wetland plant and animal diversity in India***: (10.0 Lectures)
Factors controlling dominance and diversity of wetlands, biomass, species pools, and their conservation.

403.2(WC) ***Plant adaptations to mangrove and freshwater swamps***: (10.0 Lectures)
characteristics of mangroves and freshwater swamps, Biota of mangroves, Riparian ecosystem, pit lakes; biota of fresh water swamps, functional types of wetland plants.

403.3(WC) ***Wetland as Nature's kidney: a case study***: (10.0 Lectures)
Nature and extent of amelioration capacity of wetlands, wastewater treatment in wetlands – a case study. Wetland ecosystem service and restoration

403.4(WC) ***Wetland weeds & their utilization***: (10.0 Lectures)
Objectives, benefits & limitations; major types & functions; productivity, harvesting and uses; wastewater treatment by weeds (phytoremediation); high rate algal ponds; wastewater-fed aquaculture practices in wetland areas.

403.5(WC) ***Constructed wetland and wetland restoration***: (10.0 Lectures)
Importance of constructed wetlands in treating wastes, designing and construction of wetland, optimization of efficiency, background and foundation of restoration, problems and prospects of restoration.

403.6(WC) ***Wetland conservation laws and global efforts***: (10.0 Lectures)
Major laws and conventions relating to wetland conservation, Indian conservation strategies and implementations.

Suggested readings:
Global Wetlands: Old World and New William J. Mitsch Elsevier, 1994
Original from the University of Virginia Restoration and Management of Lakes and Reservoirs George Dennis Cooke, Eugene B. Welch, Spencer Peterson, Stanley A. Nichols CRC Press, 2005
Wetlands, Water, and the Law: Using Law to Advance Wetland Conservation and Wise Use Clare Shine, Cyrille de Klemm, International Union for Conservation of Nature and Natural Resources, IUCN Environmental Law Centre IUCN, 1999
Ark of the Broken Covenant: Protecting the World's Biodiversity Hotspots John C. Kunich Greenwood Publishing Group, 2003
Management and Ecology of Freshwater Plants: Proceedings of the 9th International Symposium on Aquatic Weeds, European Weed Research Society J. M. Caffrey, P.R.F. (Editor) Barrett, European Weed Research Society, Kevin J. Murphy, P.M. (Editor) Wade Springer, 1997
Indigenous Management of Wetlands: Experiences in Ethiopia Alan B. Dixon, King's College (University of London), King's College, London, University of London School of Oriental and African Studies Contributor King's College, London Ashgate Publishing, Ltd., 2003
Wetland Drainage, Restoration, and Repair Thomas R. BiebighauserUniversity Press of Kentucky, 2007 Wetlands William J. Mitsch, James G. Gosselink John Wiley and Sons, 2007
Wetland Plants: Biology and Ecology J. K. Cronk, M. Siobhan Fennessy CRC Press, 2001

Major Elective Practical
MSCCONBMJE404
(Wetland Conservation– IV)
(Credit 2)
Learning Outcome: *At the end of this course the students will be able to identify and characterize wetland flora and fauna*

Time – 5 hrs **Full Marks: 50**

404.1(WC) Measures of phytoremediation; capacities of wetland weeds; N & P removal capacities; studies on biology of wetland dependent fauna. Measurement of wetland macrophytes; Identification of coastal flora and fauna of India.

MSCCONBMJE405
Conservation Genetics – III
(Credit Points 4)
Learning Outcome: *At the end of this course the students will be able to learn about genetic management of different populations and genetic application in forensic studies*

405.1(CG) ***Defining Management Units***: (10.0 Lectures)
Definition of Management Units and ecological importance from conservation standpoint; IUCN categories of threatened biota; genetic markers in delineation of species; genetic distances; Evolutionary Significant Unit (ESU); measurement of distances between the units and construction of cladogram.

405.2(CG) ***Genetic Management of wild populations***: (10.0 Lectures)
Genes in managing wild population; taxonomic unit vs management units; diagnosing genetic

problems and recovery measures; managing species that are not outbreeding diploid. Polymorphism and Population Survival, Polymorphic nucleotide markers and small RNA based taxonomic distinction.

405.3(CG) ***Genetic Management of captive populations***: (10.0 Lectures)
Stages of captive breeding and reintroduction; founding captive population; growth & genetic management of captive population (MHC Polymorphism and captive breeding); Ex situ conservation of plants; reproductive techniques and genome resource banks; managing inherited diseases.

405.4(CG) ***Genetic Management of reintroduced populations***: 10.0 Lectures
Reintroduction ethics; genetic adaptation; success and management in reintroduction; reintroduction and translocation; supportive breeding.

405.5(CG) ***Genetics in forensics and species biology***: (10.0 Lectures)
Molecular genetics in forensics: detecting illegal hunting; gene trees and coalescence; population size and demographic history; gene flow and population structure.

405.6(CG***) Molecular genetics in forensics & species biology***: (10.0 Lectures)
Detecting illegal hunting & collecting; understanding species biology at molecular level; gene trees & coalescence; demographic history; reproduction, parentage, founder relationship & sexing, disease, diet. Biotechnology and Conservation of Endangered Species (Polymerase Chain Reaction DNA Fingerprinting, Phyogenetics)

Suggested readings:
Evolutionary Genetics: Concepts and Case Studies Charles W. Fox, Jason B. Wolf Contributor Charles W. Fox, Jason B. Wolf
A Primer of Conservation Genetics Richard Frankham, Jonathan D. Ballou, David Anthony Briscoe, Karina H. McInnes Cambridge University Press, 2004
Introduction to Conservation Genetics: Richard Frankham, Jonathan D. Ballou and David A. Briscoe By Richard Frankham, David Anthony Briscoe, Jonathan D. Ballou, Karina H. Cambridge University Press, 2002
Evolutionary Genetics: Concepts and Case Studies Charles W. Fox, Jason B. Wolf Contributor Charles W. Fox, Jason B. Wolf Published by Oxford University Press US, 2006 Plant Conservation Genetics Robert J. Henry Haworth Press, 2006
Conservation Genetics: Case Histories from Nature John C. Avise, James Lewis Hamrick Springer, 1995
A Primer of Conservation Genetics Richard Frankham, Jonathan D. Ballou, David Anthony Briscoe, Karina H. McInnes Cambridge University Press, 2004
Introduction to Conservation Genetics: Richard Frankham, Jonathan D. Ballou and David A. Briscoe Richard Frankham, David Anthony Briscoe, Jonathan D. Ballou, Karina H. Cambridge University Press, 2002
Evolutionary Genetics: Concepts and Case Studies Charles W. Fox, Jason B. Wolf Contributor Charles W. Fox, Jason B. Wolf Oxford University Press US, 2006
Plant Conservation Genetics Robert J. Henry Haworth Press, 2006
Conservation Genetics: Case Histories from Nature John C. Avise, James Lewis Hamrick Springer, 1995

Major Elective Practical
MSCCONBMJE406
Conservation Genetics- IV
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to perform different molecular and bio-informatic techniques*

Time – 5 hrs **Full Marks: 50**

406.1(CG) Wet laboratory Techniques: Polymerase Chain reaction (PCR); cleaning up of PCR products; automated sequencing; genotyping: Restriction Fragment Length Polymorphism (RFLP), Microsatellites/Short Tandem Repeats (STRs), Single Nucleotide

Polymorphisms (SNPs), Computer laboratory Techniques: Primer design; Bioinformatics: NCBI, Blast, data mining; Relatedness and paternity analyses.

MSCCONBMJE407
Marine Bioresources – III
(Credit Points 4)

Learning Outcome: *At the end of this course the students will be able to learn about marine flora and fauna*

407.1(MB) ***Seaweeds and coral Reefs***: (10.0 Lectures)
Algal & Seaweed Bioresources, taxonomy & biogeography of sea-grasses; their distribution and uses; sea-grass beds & coastal biogeography; protection of sea-grass biome; distribution and formation of major coral reefs of India; threats to coral reefs and economy concerning reefs; economic importance of seaweeds.

407.2(MB) ***Marine parasitology***: (10.0 Lectures)
Marine parasites and their parasitic ecology; co-evolution & speciation; medical importance; economic & environmental importance of marine parasites.

407.3(MB***) Sustainable Harvesting of Marine Bioresources***: (10.0 Lectures)
Externalization of economic values of marine Bioresources through harvesting

407.4(MB***) Fin Fish, Shell fish and Reptiles***: (10.0 Lectures)
Major marine fin & shell fish and reptile wealth; economic uses; special conservation strategies – case studies.

407.5(MB) ***Marine Birds and Mammals***: (10.0 Lectures)
Major marine birds and mammal wealth; economic uses; special conservation strategies – case studies.

407.5(MB***) Migration of Marine Animals***: (10.0 Lectures)
Migration and food-web structures; flora-faunal dependence; drives for migration; study of migration pathways and conservation strategies – case studies.

Suggested readings:

Environmental Health: Ecological Perspectives Kathryn Hilgenkamp Jones & Bartlett Publishers, 2005
Seabirds & Other Marine Vertebrates: Competition, Predation, and Other Interactions Joanna Burger Columbia University Press, 1988
Introduction to the Biology of Marine Life James L. Sumich, John Francis Morrissey Jones & Bartlett Publishers, 2004
Marine Birds, Mammals and Reptiles Barry Silkstone Heinemann Library, 2001
Invitation to Oceanography Paul R. Pinet Jones & Bartlett Publishers, 2003
Principles of Animal Biology Aaron Franklin Shull, George Roger Larue, Alexander Grant Ruthven McGraw-Hill book company, inc., 1920
Original from Harvard University Laboratory and Field Investigations in Marine Life James L. Sumich, Sumich, Gordon Dudley Jones & Bartlett Publishers, 2008 Distribution and Migration of Marine Mammals in the North Pacific Area MasaharuNishiwaki 1966 Greenwood Publishing Group, 2003
Coral Reefs: Challenges and Opportunities for Sustainable Management : Proceedings of an Associated Event of the Fifth Annual World Bank Conference on Environmentally and Socially Susutainable Development By Marea Eleni Hatziolos, Anthony J. Hooten, Martin Fodor, World Bank, International Center for Living Aquatic Resources Management
Seaweeds: Their Environment, Biogeography, and Ecophysiology Klaus Lüning, Charles Yarish, Hugh Kirkman Wiley-IEEE, 1990
Ecology of Marine Parasites: An Introduction to Marine Parasitology Klaus Rohde CAB International,

1993 Marine Parasitology Klaus Rohde CSIRO, 2005
Ecosystems and Human Well-being Millennium Ecosystem Assessment Island Press, 2005

Major Elective Practical

MSCCONBMJE408
(Marine Bioresource- IV)
(Credit 2)

Learning Outcome: *At the end of this course the students will be able to determine different parameters of marine environment through field studies*

Time – 5 hrs **Full Marks: 50**

408.1(MB) Marine Bioresources: Estimation of ecological indices of mangrove community/marine inter-tidal community; estimation of phyto-pigments (Chlorophyll a, b, & c) in coastal/estuarine waters; biochemical composition of marine/estuarine flora-fauna; ecological studies on oysters; study of sequestered carbon in mangroves; identification of mangrove/inter-tidal mud-flat flora-fauna.

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