



Annexure 'A' of Agenda Item No. AC/11/01  
(Total Page A-1 to A-18) 11/01/A-01  
GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

Sector - 16C Dwarka, New Delhi - 110078

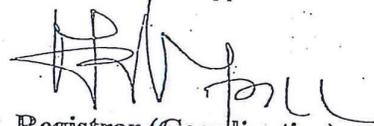
F.No. IPU/JR(C)/40th AC/2016/47

Dated: 05.03.2016

Subject- Proceedings of the 40<sup>th</sup> meeting of Academic Council.

Please find enclosed herewith the proceedings of the 40<sup>th</sup> meeting of Academic Council of Guru Gobind Singh Indraprastha University held on Tuesday, 1<sup>st</sup> March 2016 at 11.30 a.m. in the Conference Hall of the University, Administrative Block-'A' wing, Dwarka Campus, New Delhi-110078 for approval.

Observations, if any may kindly be communicated to the office of the undersigned within week, consequent to no observation(s), communicated, the proceedings will be assumed as deemed approved.

  
Jt. Registrar (Coordination)  
coordination112@gmail.com  
09868527302/011-25302135

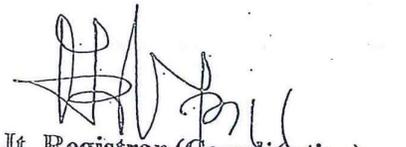
Dated: 05.03.2016

F.No. IPU/JR(C)/40<sup>th</sup> AC /2016 /47

- 1) All Deans and Directors of Guru Gobind Singh Indraprastha University
- 2) Prof.P.K.Julka, Dept. of Clinical Oncology, AIIMS, New Delhi.
- 3) Prof.M.C.Sharma, School of Education, (IGNOU), New Delhi.
- 4) Prof.M.P.Gupta, Department of Management Studies, IIT, Delhi.
- 5) Prof.A.K.Maitra, Former Director, School of Planning & Architecture, Delhi.
- 6) Prof.Karmeshu, School of Computer & System Sciences, JNU, New Delhi.
- 7) Prof. Surender kumar, Deptt. of Chemical Technology, IIT Roorkee, Uttarakhand.
- 8) Prof.J.P.Khurana, Dept. of Plant Molecular Biology, Faculty of Interdisciplinary & Applied Sciences, University of Delhi, South Campus.
- 9) Prof. Lallan Prasad, Retired Head and Dean of Dept. of Business Economics, Faculty of Applied Social Sciences, University of Delhi, South Campus.
- 10) Shri Arvind Misra; Former Dean, Faculty of Law, Dr. B.R. Ambedkar University, Agra, Ex.Director /Head, Post Graduate Deptt. of Law Agra College, Agra Former OSD (Law) to H.E. the Governor of UP, Lucknow.
- 11) Shri Sandeep Gupta, CEO, Academy of Embedded Technology, Delhi.
- 12) Prof. J.K. Garg, Professor, University School of Environment Management
- 13) Dr.Amar Pal Singh, Professor, University School of Law & Legal Studies.
- 14) Dr. Manpreet Kang, Associate Professor, University School of Humanities & Social Sciences
- 15) Dr. Meenu Kapoor, Associate Professor, University School of Biotechnology
- 16) Dr. Vaishali Singh, Associate Professor, University School of Basic and Applied Sciences

Copy for kind information of the Competent Authority:

- (i) AR to the Vice Chancellor GGSIP University
- (ii) SO to the Pro-Vice Chancellor GGSIP University
- (iii) AR to the Registrar GGSIP University

  
Jt. Registrar (Coordination)  
coordination112@gmail.com  
09868527302/011-25302135

24/01/A-02



GURU GOBIND SINGH  
INDRAPRASTHA  
UNIVERSITY

**GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY**

**FORTIETH MEETING**

**OF THE**

**ACADEMIC COUNCIL**

*DATE* : 01<sup>st</sup> March, 2016 (Tuesday)

*TIME* : 11:30 a.m. onwards

*VENUE* : CONFERENCE ROOM

**PROCEEDINGS**

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SECTOR -- 16C, DWARKA, NEW DELHI.

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AC40.02	Action Taken Report on the Proceedings of 39 <sup>th</sup> meeting of the Academic Council, held on 25 <sup>th</sup> June, 2015.	07
AC40.03	To ratify the decision to include additional information, for all programmes of studies governed by the revised the University Ordinances No. 10 and 11.	07
AC40.04	To ratify the notification of the guidelines to address the operational difficulties arisen due to revision of the University Ordinances No. 10, 11 and repealing of the University Ordinance No.27, for the student batches admitted up to the academic session 2014-2015.	07-08
AC40.05	To ratify the decision regarding the specification of degrees as per the University Grants Commission (UGC), Gazette Notification dated 05 <sup>th</sup> July, 2014 No.F.5-1/2013 (CPP-II).	08
AC40.06	To inform the Academic Council regarding the statistics of the degrees to be conferred in the Eleventh Convocation of the Guru Gobind Singh Indraprastha University.	08
AC40.07	To consider and approve the list(s) of subject experts to be appointed for various purposes by the Guru Gobind Singh Indraprastha University.	08
AC40.08	To consider and approve the modified eligibility criteria, for creation of posts i.e., "As per Guru Gobind Singh Indraprastha University Recruitment Rules" in place of "As per UGC norms", as had been approved earlier by Academic Council in its 39 <sup>th</sup> meeting held on 25.06.2015 w.r.t University School of Humanities and Social Sciences.	09
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AC40.10	To ratify the delinking of the B.Tech. and M.Tech. degrees and to run a single M.Tech. programme (in place of the two at present) as per the revised curriculum, scheme of examinations and admission criteria to be implemented by the University School of Biotechnology (USBT) from the academic session 2016-2017.	10-11
AC40.11	To ratify the implementation of revised scheme and syllabus for M.Tech. (Food Processing Technology) course, offered by the University School of Biotechnology (USBT), from the academic session 2015-2016.	11

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AC40.13	To ratify the implementation of revised scheme and syllabus for Ph.D. course work offered by the University School of Law & Legal Studies (USLLS), from the academic session 2015-2016.	11
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*hired*

41.01/A-05

AGENDA No.	AGENDA ITEM(S)	Page No.
AC40.21	To consider and approve the implementation of the minor modification(s) in the existing scheme and syllabus of Master of Technology (M.Tech.) in the following programmes approved by the Board of Studies of the University School of Information and Communication Technology (USICT), from the academic session 2015-2016:- <u>M.Tech.(Regular Programme):-</u> (i)Information Technology, (ii) Computer Science & Engineering,(iii) Information Security , (iv)Electronics & Communication Engineering, (v)Digital Communication, (vi)Signal Processing, (vii) RF & Microwave Engineering and (viii)VLSI Design <u>M.Tech.(Weekend Programme):-</u> (i) Computer Science & Engineering (ii) Information Technology (iii) Electronics & Communication Engineering	15-16
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**Agenda Item No. AC40.14: To ratify the implementation of revised scheme of evaluation and syllabus for Master of Law (One year), Alternative Dispute Resolution (ADR) course offered by the University School of Law & Legal Studies (USLLS), from the academic session 2015-2016.**

The University School of Law & Legal Studies (USLLS) has revised the scheme of evaluation and syllabus for Master of Law (One year), Alternative Dispute Resolution (ADR) course, as approved by the sub-committee of the Academic Council (12<sup>th</sup> August 2015). The same has been implemented with the approval of Competent Authority from the Academic Session 2015-2016. The Academic Council after consideration ratified the implementation of revised scheme of evaluation and syllabus for Master of Law (One year), Alternative Dispute Resolution (ADR) course for University School of Law & Legal Studies. *Annexed as Annexure 'L' of Agenda Item No AC 40.14 (Page L-01 to L-16)*

**Agenda Item No. AC40.15: To ratify the implementation of syllabus, course curriculum, scheme of evaluation, eligibility criteria and admission procedure of M. Phil (Psychiatric Social Work) course offered by the University School of Medical and Para Medical Health Sciences (USMPHS), from the academic session 2015-2016.**

The University School of Medical and Para Medical Health Sciences (USMPHS) has implemented the syllabus, course curriculum, scheme of evaluation, eligibility criteria and admission procedure of M.Phil. (Psychiatric Social Work) course, as approved by the sub-committee of Academic Council of USMPHS (31<sup>st</sup> July, 2015). The same has been implemented with the approval of Competent Authority from the Academic Session 2015-2016. The Academic Council after consideration ratified the syllabus, course curriculum, scheme of evaluation, eligibility criteria and admission procedure of M.Phil. (Psychiatric Social Work) course for USMPHS as implemented from academic session 2015-2016. The Academic Council also suggested that the Dean, USMPHS should reorganize details of the references and required readings paper-wise. *Annexed as Annexure 'M' of Agenda Item No AC 40.15 (Page M-01 to M-35)*

**Agenda Item No. AC40.16: To ratify the implementation of revised course curriculum and scheme of examinations for the following programmes offered by University School of Environment Management (USEM), from the academic session 2015-2016:-**

- (i) M.Sc. (Environment Management)
- (ii) M.Sc. (Biodiversity and Conservation)
- (iii) M.Sc. (Natural Resource Management)
- (iv) Ph.D. (Environment Sciences)

University School of Environment Management (USEM) has revised the course curriculum and scheme of examinations as approved by the sub-committee of Academic Council (31<sup>st</sup> July' 2015) for the following programmes:

- (i) M.Sc. (Environment Management)
- (ii) M.Sc. (Biodiversity and Conservation)
- (iii) M.Sc. (Natural Resource Management)
- (iv) Ph.D. (Environment Sciences)

*Amal*

The course curriculum and scheme of examinations for the above programmes have been revised as per the UGC guidelines, merging some old papers and including important aspects like wetland. The revised scheme and syllabus has been implemented with the approval of Competent Authority from Academic Session 2015-2016. The Academic Council after consideration ratified the revised course curriculum and scheme of examinations for the above programmes offered by University School of Environment Management as implemented from academic session 2015-2016.

*Annexed as Annexure 'N' of Agenda Item No. AC40.16 (Page N-01 to N-4)*

**Agenda Item No. AC40.17: To ratify the implementation of revised scheme and syllabus of Ph.D. course work of University School of Education (USE), from the academic session 2015-2016.**

In pursuance of the provision of regulations of the University Ordinance 12 for programmes leading to the degree of Doctor of Philosophy (Ph.D.), the University School of Education on the recommendation of sub-committee of the Academic Council (15<sup>th</sup> December 2015) has updated and revised scheme and syllabus for Ph.D. coursework. The revised scheme and syllabus has been implemented with the approval of Competent Authority from Academic Session 2015-2016. The Academic Council after consideration ratified the revised scheme and syllabus for Ph.D. coursework implemented from Academic Session 2015-2016.

*Annexed as Annexure 'O' of Agenda Item No. AC40.17 (Page N-01 to N-10)*

**Agenda Item No. AC40.18: To ratify the implementation of revised course curriculum and scheme of examinations for Ph.D. courses in the discipline of (i) Physics (ii) Chemistry (iii) Mathematics offered by the University School of Basic & Applied Sciences (USBAS) from the academic session 2015-2016.**

In pursuance of the provision of Regulations of the University Ordinance 12 for programmes leading to the degree of Doctor of Philosophy (Ph.D.), the University School of Basic & Applied Sciences has revised the course curriculum and scheme of examinations for Ph.D. courses as approved by the sub-committee of Academic Council (17<sup>th</sup> September, 2015) in the following disciplines:

- (i) Physics
- (ii) Chemistry
- (iii) Mathematics

The revised curriculum and scheme of examinations for Ph.D. programme has been implemented with the approval of Competent Authority from academic session 2015-2016.

The Academic Council after consideration ratified revised course curriculum and scheme of examinations for the above programmes as implemented from Academic Session 2015-2016.

*Annexed as Annexure 'P' of Agenda Item No. AC 40.18 (Page - P-01 to P-33).*

*Pratik*



**University School of Environment Management**  
**Guru Gobind Singh Indraprastha University**

**SCHEME OF EXAMINATION**  
**and**  
**SYLLABUS**

**OF**

**MASTER OF SCIENCE**  
**(BIODIVERSITY & CONSERVATION)**

**(w.e.f. ACADEMIC SESSION - 2015-2016)**

**Entrepreneurship | Employability | Skill Development**

# GURUGOBINDSINGHINDRAPRASTHAUNIVERSITY

New Delhi 110078

## SCHEME OF EXAMINATION

Master of Science (Biodiversity and Conservation)

First Semester

Paper Code	Paper Title	L	T	P	Credits
<b>Theory Papers</b>					
<b>EMBC-601</b> (Foundation Course)	Fundamentals of Biodiversity and Conservation	4			4
<b>EMBC-603</b>	Taxonomy & Systematics of Plants and Microbes	4			4
<b>EMBC-605</b>	Species Diversity and Conservation	4			4
<b>EMBC-607</b>	Genetic Diversity and Conservation	4			4
<b>EMBC-609</b>	Ecosystem Diversity and Conservation	4			4
<b>EMBC-611</b>	<b>Seminar/Term Paper</b>	1			1
<b>Practical</b>					
<b>EMBC-651</b>	Plant Taxonomy Lab			4	2
<b>EMBC-653</b>	Molecular Genetic Assessment Lab			4	2
<b>EMBC-655</b>	Ecology Lab			4	2
<b>EMBC-657</b>	<b>Field Work</b>				1
	<b>Total</b>				<b>28</b>

## Second Semester

Theory Papers		L	T	P	Credits
EMBC-602(Foundaion Course)	Animal Taxonomy and Systematics	4			4
EMBC-604	Biodiversity Conservation and Climate change	4			4
EMBC-606	Biotechnological and Phylogenetic Approaches to Biodiversity Conservation	4			4
EMBC-608	Geoinformatics and Biodiversity Assessment	4			4
<b>GenericElectives (Any one)</b>					
EMBCGE-616	Plant Reproductive Ecology	4			4
EMBCGE-618	Animal Ecology and Behaviour	4			4
EMBCGE-620	Environmental Stress Biology	4			4
EMBCGE-622	Aquatic Ecosystems and Wetlands	4			4
EMBCGE-624	Wildlife Biology	4			4
<b>Practicals</b>					
EMBC-652	Animal Taxonomy and Systematics Lab			4	2
EMBC-654	Geoinformatics Lab			4	2
EMBC-656	Phylogeny Lab			4	2
EMBC-658	Field Work				1
	<b>Total</b>				<b>27</b>

# After 2<sup>nd</sup> semester students will undergo summer training for six weeks. The summer training will be in house or in different institutions.

### Third semester

Theory Papers		L	T	P	Credits
<b>EMBC-701</b>	Biodiversity Conservation, Human Society and Ethics	4			4
<b>EMBC-703</b> ( <i>Foundation Course</i> )	Conservation Policies and Law	3			3
<b>EMBC-705</b>	Development Communication in Conservation	4			4
<b>EMBC-707</b>	Biostatistics	4			4

Open-Electives (Any one) **					
<b>EMOE731</b>	Climate change mitigation & adaptation	4			4
<b>EMOE733</b>	Disaster Risk Reduction and Management	4			4
<b>EMOE735</b>	Urban Biodiversity Strategies for Conservation	4			4
<b>EMOE 737</b>	Human aspects of Biodiversity and Environment	4			4
<b>EMOE739</b>	Corporate Social Responsibility	4			4
<b>EMOE741</b>	Sustainable Ecotourism	4			4

Practicals					
<b>EMBC-751</b>	Conservation Communication Lab			4	2
<b>EMBC-753</b>	Web Designing Lab for Conservation			4	2
<b>EMBC-755</b>	Biostatistics and Computer Applications Lab			4	2
<b>EMBC-757</b>	Summer Training Report*				3
	<b>Total</b>				<b>28</b>

- Summer Training (6-8 Weeks) outside University in any Industry/Organization.
- \*\*Students will opt for one relevant open elective paper offered by USEM or by any other University School of GGSIPU

The student will require to earn 100 credits for the award of the degree. The students will not have the option to drop any course covered in scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination of the programme.

### Fourth Semester

Paper ID	Paper Title	L	T	P	Credit
EMBC-702	Seminar and Progress Report <sup>1</sup>				4
EMBC-704	Dissertation <sup>2</sup>				22
	Credit				26
	Total Credits				109 <sup>3</sup>

#### Project Work:

Project Work/Dissertation is intended to provide the students an opportunity to attain specialization in an area of study covered in the programme. Each student will have to select a topic of the project based on his/her area of specialization in the 3rd Semester. In the 3rd Semester, students are expected to define the problem, area of work and prepare a Project Plan. Students will implement the project in the 4th Semester in the natural habitat or area. Students will submit M.Sc. dissertation at the end of Fourth semester. Final evaluation of the dissertation will be done through presentation and Viva-voce.

<sup>1</sup>A full semester project work will be allotted in the areas selected by the faculty. Apart from the regular interaction with the faculty supervisor, in mid semester students have to give a seminar on progress of the project in front of all the faculty members.

<sup>2</sup>Equal number of the students will be provided within the faculty members for supervision of the project work according to expertise available. The assessment will be made on the basis of dissertation and presentation. The evaluation of dissertation will be based on the thesis and viva-voce by the Board of Examiners comprising of external expert/s, internal supervisor and faculty members. The name of the External Examiner/s shall be approved by the School's Board of Studies.

<sup>3</sup> **The student will require to earn 100 credits for the award of the degree. The students will not have the option to drop any course covered in scheme of examination. He/she will be required to register for all the courses listed in the scheme of examination of the programme.**

**Total Credits of the course**

First Semester	28
Second Semester	27
Third Semester	28
Fourth Semester	26
<b>Total</b>	<b>109</b>

**First Semester****THEORY****Paper Code-EMBC-601****L      T    Credits    Hours****Paper ID- 03601****4      0      4            48****Paper Title – Fundamentals of Biodiversity and Conservation (Foundation Course)****Unit 1 - Biodiversity –Concept and definition**

Scope and Constraints of Biodiversity Science, Composition and Scales of Biodiversity: Genetic Diversity, Species/Organismal Diversity, Ecological/Ecosystem Diversity, Landscape/Pattern Diversity, Agrobiodiversity, Bicultural Diversity and Urban Biodiversity

**Unit 2 - Causes of Biodiversity**

Origin of Species /Speciation:History of the Earth and Biodiversity patterns through Geological times; Current Centers of Biodiversity

**Unit 3 - Values of Biodiversity**

Instrumental/Utilitarian value and their categories, Direct use value;Indirect/ Non-consumptive use value, Introduction to Ecological Economics; Monetizing the value of Biodiversity;Intrinsic Value;Ethical and aesthetic values, Anthropocentrism, Biocentrism, Ecocentrism and Religions; Intellectual Value;Deep Ecology

**Unit 4 - Threats to Biodiversity**

Habitat Destruction, Fragmentation, Transformation, Degradation and Loss: Causes, Patterns and consequences on the Biodiversity of Major Land and Aquatic Systems

Invasive Species: their introduction pathways, biological impacts of invasive species on terrestrial and aquatic systems

Pollution: Impacts of Pesticide pollution, Water pollution and Air Pollution on biodiversity

Overexploitation: Impacts of Exploitation on Target and Non-target Terrestrial and Aquatic species and Ecosystems

Extinction: Types of Extinctions, Processes responsible for Species Extinction, Current and Future Extinction Rates, IUCN Threatened Categories, Sixth Extinction/Biological Crisis

**Books Recommended:**

1. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. **Principles of Conservation Biology**. Sinauer Associates, Inc., USA.
2. Krishnamurthy, K. V. 2003. **Textbook of Biodiversity**. Science Publication.
3. Primack, R. 2006. **Essentials of Conservation Biology**.Sinauer Associates, Inc., USA.
4. Hambler, C. 2004. **Conservation**. Cambridge University Press.
5. Van Dyke,F.2008.**Conservation Biology Foundations, Concepts, Applications** 2<sup>nd</sup> Edition, Springer.

## First Semester

### THEORY

Paper Code-EMBC- 603	L	T	Credits	Hours
Paper ID-03603	4	0	4	48
Paper Title - Taxonomy and Systematics of Plants and Microbes				

#### **Unit 1 - Principles and Practices in taxonomy**

Introduction to Taxonomy and Systematics; Significance of Plant systematics, Basic Components of Taxonomy and Systematics: Identification, Description and Nomenclature, Phylogeny and Classification

Major Systems of Classification: Natural Systems (Bentham & Hooker); Phylogenetic Systems (Angiosperm Phylogenetic Group –APG), The International Code of Nomenclature (ICBN/ICN)

Introduction to Phenetic Methods (Taxometrics) and Phylogenetic Methods (Cladistics) The International Code of Nomenclature of Bacteria (ICNB) or Bacteriological Code (BC)

#### **Unit 2 -Documentation of Plants**

Process of Plant Identification: Herbaria and data Information Systems; Herbarium Policies; Major Herbaria of the World and India; Botanical Gardens; Taxonomic literature; Taxonomic Keys; Identification through Websites/internet, Measuring diversity :Alfa, Beta and Gamma diversity, its relative importance and analysis Plant Geography: Physical Geography of Earth, Aims and Scope of Plant Geography, Phytochoria

#### **Unit 3 -Establishing Priorities: the Role of Taxonomy**

Plant taxonomy and Reintroduction, Taxonomy: the framework for the botanical garden in conservation and habitat restoration

Good networks: Global Biodiversity Information Facility (GBIF)

Biodiversity database – Species diversity, Information sources by assembling, merging and linking databases; E-flora

#### **Unit 4 - Taxonomy and the future of Plant Diversity Science**

Taxonomy in the implementation of the Convention on Biological Diversity (CBD), Global Strategy for Plant Conservation (GSPC) Global Taxonomic Initiative (GTI), National Biodiversity Strategy Action Plan (NBSAP)

#### **Books Recommended:**

1. Simpson, M.G. 2006. **Plant Systematics**. Elsevier academic Press.
2. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. **Principles of Conservation biology**. Sinauer associates, Inc., USA.
3. Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. A. & Donoghue, M.C. 2008. **Plant Systematics – A Phylogenetic Approach IIIrd Edition**. Sinauer Publication.
4. Radford, A. E., Dickson, W. C., Massey, J. R., Bell, C. R. 1974. **Vascular Plant Systematics**.
5. Singh, G. 2008. **Plant Systematics: Theory and Practice**. Oxford & IBH Publishing Co. Pvt. Ltd.

6. Leadlay, E. & Jury, S. 2006. **Taxonomy and Plant Conservation**. Cambridge University Press
7. Gupta, R. (Ed.) 2012. **Plant Taxonomy: Past, Present, and Future**. Dr. Pritipal Singh Festschrift, The Energy and Resources Institute (TERI) Press.
8. Atlas, R. M. 1995. **Principles of microbiology**. St. Louis, MoS by Publication.
9. Hollingworth, P.M., Bateman, R. M., & Gornall, R. J. 1999. **Molecular Systematics and Plant Evolution**. Systematics Association Taylor & Francis.
10. Crawford, D.J. 2003. **Plant Molecular Systematics**. Cambridge University Press, Cambridge, UK.
11. Cronquist, A. 1981. **An Integrated System of Classification of Flowering Plants**. Columbia University Press, New York.
12. Victor, J.E., Fish, L., Smithies, S.J. & Mossmer, M. 2004. **Herbarium Essentials**. Southern African Botanical Diversity Network Report No. 25,
13. Felsenstein, J. 2004. **Inferring Phylgenies**. Sinauer Publication.
14. Abbott et al. 1985. **Taxonomic analysis in biology: computers, models, and databases** Columbia University Press, NY [Chapter 7, covering phenetic methods].  
**Suggested Reading:**
15. Angiosperm Phylogeny Group (2003). An update of the Angiosperm Phylogeny Group classification for the orders and families of the flowering plants: APG II. *Botanical Journal of the Linnaean Society* 141: 399-436.

## First Semester

### THEORY

<b>Paper Code- EMBC-605</b>	<b>L</b>	<b>T</b>	<b>Credits</b>	<b>Hours</b>
<b>Paper ID-03605</b>	<b>4</b>	<b>0</b>	<b>4</b>	<b>48</b>
<b>Paper Title - Species Diversity and Conservation</b>				

#### **Unit 1- Density independent and dependent growth**

Density independent growth: Fundamentals of population growth, Types of models, Density independent versus density dependent growth, Geometric growth in populations with non-overlapping generations, Exponential growth in populations with overlapping generations, The finite rate of increase and the intrinsic rate of increase

Density dependent growth and intraspecific competition: Density dependence in populations with discrete generations, Density dependence in populations with overlapping generations, Non-linear density dependence of birth and death rates and the Allee effect, Behavioral aspects of intraspecific competition

Population regulation: Understanding population regulation, combining density dependent and density independent factors, Tests of density dependence

#### **Unit 2 -Metapopulation Ecology**

Metapopulation and spatial ecology, Mac Arthur and Wilson and the equilibrium theory, Levins or classical metapopulation, Extinction in metapopulations, Metapopulations dynamics of two local populations, Source-sink metapopulations and the rescue effect, Non-equilibrium and patchy metapopulations, Spatially realistic models, Minimum viable metapopulation size, Assumptions and evidence for the existence of metapopulations in nature

#### **Unit 3- Community Ecology**

Interspecific interactions - Interspecific Competition, Host-Parasite interactions, Predator-prey interactions, Plant herbivore interaction

Community ecology - Structure and function of communities, Functional aspects of communities, Stability and change in communities

Regulation of communities - Role of species diversity, Role of predators, Role of competition, Role of nutrients, other factors

#### **Unit 4- Applied Population Biology**

Gathering Ecological Information, Monitoring Population of species, establishing new populations, Behavior of released animals, Evaluation of successful programs through case studies

Ex-situ conservation strategies: An overview, Botanical Gardens and Arboreta, Zoological Parks, Aquaria, Seed Banks

#### **Books Recommended:**

1. Hastings, A. (Ed.). 1953 Population biology: concepts and models. Springer Science and Business Media
2. Neal, D. 2004. Introduction to Population Biology. Cambridge University Press.
3. Vandermeer, J. H. and Goldberg, D. E. 2013. Population Ecology: First principles. Princeton University Press.
4. Begon, M., Mortimer, M. and Thompson, D. J. 2009. Population ecology: A unified study of animals and plants. John Wiley & Sons.
5. Lomnicki, A. 1988. Population Ecology of Individuals. Princeton University Press.
6. Rockwood, L. R. 2015. Introduction to Population Ecology. John Wiley & Sons.
7. Smith, R. L. and Smith, T. M. 2014. Elements of Ecology. Benjamin-Cummings Publishing Company.
8. Primack, R. 2014. Essentials of Conservation Biology (Sixth Edition). Sinauer Associates, Inc., USA
9. Morris, W. F. and Doak, D. F. 2002. Quantitative Conservation Biology: Theory and practice of Population Viability Analysis. W. H. Freeman Publishers.
10. Landi, R., Engen, S. and Saether, B. 2003. Stochastic population dynamics in Ecology and conservation. Oxford University Press.
11. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.

## FIRST SEMESTER

### Theory

**Paper code –EMBC-607**

**Paper ID - 03607**

**Paper Title - Genetic Diversity and Conservation**

**L T C Hours**

**4 0 4 48**

#### **Unit 1 -Genetic Variation**

Definition and importance of genetic variation, Within individuals, within and between populations

#### **Unit 2 -Understanding population genetics**

Measuring genetic diversity: The Hardy-Weinberg law; genetically effective populations size, Gene flow-Genetic pollution and gene erosion

#### **Unit 3 -Evolutionary forces for genetic variation**

Genetic drift: Wahlund effect, Inbreeding depression, Out breeding depression, Mutation, Natural selection: Genetic load and Mutation-selection balance

#### **Unit 4- Conservation genetics and management**

Time scale of concern in species revival; Use of genetic information in identification and prioritization of groups for conservation, for designing and implementation of reproductive strategies in plants and animals, and in population estimation; Understanding different levels of population exploitation on of genetic diversity.

#### *Books recommended*

Gardner, E. J. 1975. **Principles of Genetics**. John Wiley and Sons.

Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. **Principles of conservation biology**.

Sinauer associates, Inc., USA.

Hamilton, M. 2009. **Population Genetics**. Wiley-Blackwell Publications, USA

Hedrick, P. W. 1999. **Genetics of Population**. Jones and Bartlet Publishers, Inc., London.

## First Semester

### THEORY

Paper Code- EMBC-609	L	T	Credits	Hours
Paper ID-03609	4	0	4	48
Paper Title - Ecosystem Diversity and Conservation				

#### **Unit I -Ecosystem concept**

Introduction and overview of ecosystem ecology - History of ecosystem ecology, Ecosystem structure and functioning, Ecosystem diversity and landscapes, Ecosystem resilience and change, Trophic dynamics and temporal dynamics, Ecological efficiencies, Human induced Ecosystem change, Urban Ecosystem

Species effects on ecosystem processes- Overview, Functional type effects, Functional type response, integrating the effects of traits on ecosystems, Species interaction and ecosystem processes, Ecosystem Services

#### **Unit 2- Landscape heterogeneity**

Concept of landscape heterogeneity, Causes of spatial heterogeneity, Patch interactions on the landscape, Scale concept and hierarchy theory, Fractal landscapes, Quantifying landscape pattern, Spatial heterogeneity in ecosystem processes

#### **Unit 3- Restoration Ecology**

Introduction and philosophy, Ecological views of recovery, Approaches to restoration, Manipulation of physical and chemical environment, Manipulation of biota, Guidelines for restoration, Case study of a successful restoration project

#### **Unit 4 - Protected Areas**

History, definition, values and framework; Global Protected Area Framework, Convention – IUCN Protected Area management, Types of Protected Area, Extent of Protected Area, Management of Protected Area

Establishment of Protected Area- Need for comprehensive global systems, National and bioregional reserve system, Systemic Reserve selection method, Planning process for establishment of Protected Area, Management principles of Protected Area, Threats to Protected Area

Community conserved Areas (CCAs) - Range and significance of CCAs, Legal and policy context, Limitation and problems, Management principles

#### **Books Recommended:**

1. Lockwood, M., Vorboys, G. and Kothari A. (Ed.). Managing Protected Areas
2. Stuart, C., Spalding, M and Jenkins, M. the world's Protected Areas: Status, Values and prospects in 21<sup>st</sup> century
3. Turner, M.G., Gardner, R. H. and O'Neill, R. V. Landscape ecology in theory and practice: pattern and process
4. Chapin, F.S. Pamel, A. M. and Vitousek, P Principles of terrestrial Ecosystem ecology

5. Perrow, M. R. and Davy, A. J. Handbook of ecological Restoration Vol I Principles of restoration
6. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.

## First Semester

### Practical

Paper Code- EMBC- 651

P Credits Hours

Paper ID-03151

4 2 4/wk

Paper Title - Plant Taxonomy Lab

1. To study the field collection, preservation and identification of Algae.
2. To study the field collection, preservation and identification of Bryophytes.
3. To study the field collection, preservation and identification of Pteridophytes.
4. To study the field collection, preservation and identification of Gymnosperms.
5. Study of vegetative and floral characters of the following families: Malvaceae, Cucurbitaceae, Fabaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Lamiaceae, Capparaceae, Asclepiadaceae, Acanthaceae, Euphorbiaceae, Liliaceae and Poaceae (families most likely to be available during August — November).
6. Identification of selected taxa using taxonomic keys.
7. Familiarity with local flora and herbarium techniques.
8. Use of computers/internet for data collection and identification.
9. **\*Group Activity:** Field work outside Delhi in any part of India to study flora of that region, Preparation of Field Report and Submission of Herbarium in groups of 4-5, Field based Viva –Voce.

\*Group Activity: Out of 40 % marks for internal assessment, 20% marks shall be dedicated to the field work assessments

#### **Books Recommended:**

1. Lawrence, G. H. M. 1964. **Taxonomy of Vascular Plants**. Oxford & IBH Publishing Co. Calcutta.
2. Singh, G. 2008. **Plant Systematics: Theory and Practice**. Oxford & IBH Publishing Co. Pvt. Ltd.
3. Victor, J.E., Fish, L., Smithies, S.J. & Mossmer, M. 2004. **Herbarium Essentials**. Southern African Botanical Diversity Network Report No. 25, 1-103.
4. Books for Algae
5. Bryophytes
6. Pteridophytes
7. Sahni, K.C. 1991. **Gymnosperms of India and adjoining Regions**. Bishan Singh & Mahendra Pal Singh, Dehradun.

**First Semester****Practical****Paper Code- EMBC-653****Paper ID-03653****Paper Title- Molecular Genetic Assessment Lab**

<b>P</b>	<b>T</b>	<b>Credits</b>	<b>Hours</b>
<b>4</b>	<b>0</b>	<b>2</b>	<b>4/wk</b>

1. Isolation of animal/ plant DNA and its quantification by spectrophotometric method.
2. To study polymorphism among different species by separation of whole soluble proteins using SDS PAGE
3. To amplify DNA using PCR technique

## First Semester

### Practical

Paper Code- EMBC-655	P	T	Credits	Hours
Paper ID-03655	4	0	2	4/wk
Paper Title- Ecology lab				

1. Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure
2. Study the community structure using quadrat method by establishing minimum size and minimum number of quadrats
3. Study of community structure and assessing frequency of the species as assessed by Raunkiaer (1934). Prepare a frequency diagram and divide the species into classes based on percentage frequency (Raunkiaer, 1934)
4. Study of community structure and assess the density and abundance of the species
5. Study of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species
6. Understand the concept of community coefficient by comparing the frequency of two communities
7. Assessment of  $\beta$  diversity to measure the degree of turnover in species composition along a gradient or transect
8. Estimating  $\beta$  diversity by employing similarity measures like Jaccard measure and Sorenson measure and species diversity by Simpsons Index
9. Study the dispersion of the species by calculating mean and variance of species
10. Assess the soil texture by mechanical method and pH and conductivity of soil using pH meter and conductivity meter

#### **Books Recommended:**

1. Trivedy, R. K.; Goel, P.K. and Trisal, C. L. 1998. Practical methods in ecology and environmental science. Enviro Media publishers, Karad Maharashtra
2. Magurran, A. E. 1988 Ecological Diversity and its Measurement. Princeton University Press, USA
3. Misra, R. 2013 Ecology Workbook. Scientific publishers, India.

## Second Semester

### Theory

Paper Code: EMBC-602

Paper ID: 03602

Paper title – Animal Taxonomy and Systematics

L T C Hours

4 0 4 48

#### **Unit 1 - Introduction to Animal Taxonomy and Systematics**

Brief history and definition, the importance of Taxonomy in biodiversity and conservation, National and International organizations associated with taxonomic studies.

#### **Unit 2 -Theory and Practice of Biological Classification**

Binomial and trinomial nomenclature; Schemes of classification (artificial, natural and phylogenetic); The species concept. Intraspecific categories, Super species, Population taxonomy, Taxonomic hierarchy.

#### **Unit 3 -Material and Trends in Animal Taxonomy and Systematics**

Material basis of animal taxonomy and systematic; Trends in Animal Taxonomy and Systematics; Lineage change; Phenetic, Cladistic and Evolutionary classification; Numerical taxonomy and its applications

#### **Unit 4 - Methodology used in Taxonomy**

Collection and preservation techniques in animals (Insects-butterfly and moth, Amphibia, Reptiles, and Mammals); Curating collections; Taxonomic keys- Kinds, merits and demerits of different types; The International Code of Zoological Nomenclature (ICZN) and the rules of Zoological Nomenclature; Future of systematics.

#### **Books Recommended:**

Kapoor, V. C. 1998. **Theory and Practice of Animal Taxonomy**.Oxford and IBH publishing.

Mayr, E and P. D. Ashlock. 1991. **Principles of Systematic Zoology**. MacGraw-Hill,inc., New Delhi.

Narendran, T. C. 2006. **An Introduction to Taxonomy**.Zoological Survey of India, Kolkata.

Simpson, G. G. 1962. **Principles of Animal Taxonomy**. Oxford Book Company, New York

## Second Semester

### THEORY

Paper Code- EMBC-604	L	T	Credits	Hours
Paper ID-03604	4	0	4	48
Paper Title – Biodiversity Conservation and Climate Change				

#### **Unit 1- Introduction to Conservation Biology**

The history and distinctions of conservation Biology, Emergence of Global Conservation (Developing and Developed Nations)

**Importance of conservation:** In response to expanding anthropogenic demands, In response to global climate changes, Multidimensional aspects of conservation biology, Biogeographic classification

#### **Unit 2 - Conservation challenges in the Twenty first century**

Urbanisation; Creating knowledge society, Conflict management and decision making, Management of introduced species.

#### **Evaluation of priorities for conservation of habitats and species:**

Selection criteria for protection of species – species quality, IUCN Guidelines for Red List categories and criteria (version 7.0), Red List of Indian Flora and Fauna, Selection criteria for protection of habitats – hotspots, Conservation indices.

#### **Unit 3 -Climate and Climate Change**

What is Climate and what is Climate Change?

Nature of Climate Change: Observed and Projected Changes in Climate (Atmospheric changes in Green House Gases and Aerosols, Earth's Surface Temperature and Precipitation, Climate Variability and Extreme Climatic Events, Snow Cover, Sea and River Ice, Glaciers and Sea Levels), Implications of rapidly rising CO<sub>2</sub>.

Intergovernmental Panel on Climate Change (IPCC): Definition of Impacts, Adaptation and Mitigation; Climate Change Policy of India.

#### **Unit 4 - Global Biological Impacts of Climate Change**

Predicted Biological impacts, Observed Biological impacts on Species and Ecosystems; Projected impacts of changes in Mean Climate and Extreme Climate Events on Terrestrial (including Aquatic) and Marine Ecosystems, Climate Change and Gender Equality; Projected Impacts on Traditional and Indigenous People

#### **Conservation Planning and Climate Change**

The Bioclimatic Envelope Model for individual species; Climate Change -Integrated strategies for Conservation; Predictions on future responses of ongoing Climate Change on Biodiversity, Potential Adaptation Options and their consequences on Ecosystems and Biodiversity, REDD<sup>+</sup>, Synergies between Sustainable Use of Biodiversity and Climate Change

**Books recommended:**

1. Groom, M. J., Meffe, G. R. and C. R. Carroll. 2006. **Principles of Conservation Biology**. Sinauer Associates, Inc., USA.
2. Primack, R. 2006. **Essentials of Conservation Biology**. Sinauer associates, Inc., USA.
3. Hambler, C. 2004. **Conservation**. Cambridge University Press.
4. Van Dyke, F. 2008. **Conservation Biology Foundations, Concepts, Applications** 2<sup>nd</sup> Edition, Springer.

## Second Semester

### Theory

Paper Code - EMBC- 606

L T C Hours

Paper ID - 03606

4 0 4 48

Paper Title - Biotechnological and Phylogenetic Approaches to Biodiversity Conservation

#### **Unit 1- An Introduction to Conservation Biotechnology**

An overview: Role of biotechnology in biodiversity conservation (value addition, characterisation, monitoring and conservation of biodiversity; negative impacts of biotechnological uses and role of conservation professionals to address them); Ethical issues related to biotechnological uses of biodiversity in Indian perspective; How to meet both goals of biotechnology revolution and biodiversity conservation in twenty first century?

#### **Unit 2 -Molecular Approaches to assess Biodiversity**

Polymerase Chain Reaction (PCR), Real time PCR; Introduction to Molecular Markers: Allozyme, Randomly Amplified Polymorphic DNA (RAPD), Restriction Fragment Length Polymorphism (RFLP), Amplified Fragment Length Polymorphism (AFLP), Single Sequence Repeats (SSR), DNA fingerprinting, Single Nucleotide Polymorphism (SNP); Cryopreservation

#### **Unit 3 - Introduction to Phylogenetics**

History of Systematics, Introduction to cladistics/Phylogenetics, Darwin's Theory to Hennig's Principle

**Introduction to Phylogentic Trees:** Tree Terminology

**Construction of Phylogenetic Trees:** Homology, Homoplasy, Character Analysis (Character, Character State, character selection, character state transformation series, character weighting, polarity, character-taxon matrix); Cladogram Construction (apomorphy, plesiomorphy, recency of common ancestry, monophyly, non-monophyly, paraphyly); Parsimony Analysis (Rooted and Unrooted trees, character optimization, polytomy, reticulation, outgroup comparison); Consensus trees, Long Branch Attraction, Maximum Likelihood, Bayesian Analysis, Cladogram Robustness; Cladogram Analysis Phylogenetic Classification, Character Evolution, Biogeography and Ecology, Ontogeny and Heterochrony.

**Molecular Phylogenetics:** Measuring genetic change, Sequence alignment and homology, Genetic distance, Measuring evolutionary change on a tree, Inferring molecular Phylogeny, Molecular Clock

#### **Unit 4 - Applications of Morphological and Molecular Phylogenetics:**

Organismal Phylogeny; Gene Trees and Species Trees; Host-parasite cospeciation; Age and Rate of Diversification; Phylogenies in molecular Epidemiologies; Organismal Bar Coding; Phylocode Case Studies from Plants, Animals and Microbes

#### **Books Recommended**

1. Benson, E.E. 1999. **Plant Conservation Biotechnology**. Taylor and Francis, London

2. Henry, R. J. 1997. **Practical Application of Plant Molecular Biology**. Chapman and Hall Publication, London.
3. Pandit, M. W., Shivaji, S and Singh, L.2007. **You deserve, We Conserve-A Biotechnological Approach to Wild Life Conservation**. I.K.International Publishing House Pvt.Ltd. New Delhi.
4. Glick, B. R. and J. J. Pasternak. 2003. **Molecular Biotechnology: Principles and Application of Recombinant DNA**. ASM Press, Washington, D.C.
5. Primrose, S. B. Twyman, R. M. and R. W. Old, 2001. **Principles of Gene Manipulation**. Blackwell Science Ltd.
6. Abbott et al.1985.**Taxonomic analysis in biology: computers, models, and databases** Columbia University Press, NY [Chapter 7, covering phenetic methods].
7. Wiens , J. J. (ed.) 2000Phylogenetic Analysis of Morphological Data Smithsonian Institution Press, Washington, D.C. [] [Chapter 5]
8. Simpson,M.G. 2006.**Plant Systematics**. Elsevier Academic Press. [Chapter1,2]

## Second Semester

### Theory

Paper Code: EMBC-608

Paper ID: 03608

Paper title –Geoinformatics and Biodiversity Assessment

L T C Hours

4 0 4 48

#### **Unit 1: Introduction to Remote Sensing (RS)**

Definition, basics, principles and types of remote sensing, electromagnetic spectrum, radiation laws, atmospheric effects, basics of optical, thermal and microwave remote sensing, history of remote sensing, resolution types, EMR interaction, spectral signatures of different objects, platforms and sensors. Visual image interpretation tools and techniques. Indian satellite missions. Digital image processing (DIP) techniques.

#### **Unit 2: Geographic Information System (GIS)**

Basic, principles and components of GIS, spatial information and spatial data types, geographic phenomena, geographic field, geographic objects and boundaries, raster based GIS data processing with both regular and irregular tessellations, vector based GIS data processing and topology, spatial relations, spatial analysis. Map projections and coordinate systems.

#### **Unit 3: Global Positioning Systems (GPS)**

Basics of GPS, satellite generation, positioning services, types of Survey of India (SOI) topographical maps, numbering systems of SOI maps, interpretation of SOI topographical maps.

#### **Unit 4: Applications and case studies**

Natural resource management, coastal zone management, forestry and wildlife conservation and management, biodiversity loss due to mining, biodiversity mapping and modelling. The future possible techniques and applications.

#### **Books Recommended:**

1. Jensen, John R. 2009. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.
2. Joseph, George. 2005. Fundamentals of Remote Sensing, 2nd Edition. University Press India.
3. Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007. Remote Sensing and Image Interpretation. Wiley India. 18
4. Sabins, Floyd F. 2007. Remote Sensing: Principle and Interpretation. Waveland Press.
5. Jensen, John R. 2004. Introductory Digital Image Processing: A Remote Sensing Perspective. Prentice Hall.
6. Janssen, Lucas L.F., and Grrit C. Huurneman. 2001. Principle of Remote Sensing. ITC Educational Text Book series 2. International Institute of Geoinformation Science and Earth Observation (ITC). Enschede.
7. Lo, C.P., and Albert K.W. Yeung. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
8. Longley, Paul A., Michael F. Goodchild, David J. Maguire and David W. Rhind. 2005. Geographic Information System and Science, 2nd Edition. John Wiley and Sons.

**Second Semester**  
**Theory (Generic Electives)**

Paper Code -EMBCGE-616

L T C Hours

Paper ID -03616

4 0 4 48

Paper title - Plant Reproductive Ecology

**Unit 1 - Introduction and Application of Reproductive Ecology**

Reproductive Ecology in Conservation Biology, Crop Productivity and Release of Transgenics

**Methods to Study the Reproductive Ecology**

Selection of Plant Species, Study sites, Sample size, Special Requirements in the Field, Spatial and Temporal data collection, Documentation and Statistical Analyses

**Phenology:** Population Phenology, Floral Phenology, Community Phenology, Protocols

Floral /Cone Morphology and Sexuality and Reproductive Allocation

**Unit 2 -Pollen and Pistil/Cone Biology**

Pollen production, Pollen fertility and Viability, Pollen Vigor and Pollen Morphology; Protocols Stigma /Ovule Receptivity; morphology and anatomy of the stigma/ style/ovule; Protocols

**Pollination Ecology/Syndrome**

Anemophily, Hydrophyly, Zoophily: Floral /Cone Attractant and Rewards, Nocturnal pollination, Non-Mutualistic Pollination, Cone/Floral visitors and Pollinators, Restrictions to Pollinators, Pollination Efficiency, Pollen Travel and Gene Flow ; Protocols

**Pollen-Pistil/Ovule Interaction and Breeding System**

Evolutionary Significance of Pistil /cone in breeding, Pollen Germination Pattern and Fertilization; Protocols

**Unit 3 - Fruit and Seed Biology**

Types of Fruits and Seeds, Seed Viability and Germination Pattern, Seed Dormancy and seed coat Structure; Methods to overcome seed Dormancy

Seed Dispersal Mechanisms; Seed Rain; soil Seed Bank: Protocols

**Unit 4 - Seedling Recruitment**

Constraints for Seed Production, Seed Dispersal, seed Germination, seedling Establishment, Climate Change and Phenological Adaptations, Regeneration Pattern in the wild habitat and in Ex-situ environment

**Books Recommended:**

1. Willmer , P. 2011.**Pollination and Floral Ecology**. Princeton University Press
2. Waser, N.M. Ollerton, J.(eds.).2006.**Plant Pollinator Interactions:from specialization to generalization**.The University of Chicago Press.Chicago.
3. Sodhi ,N.S.& Ehrlich P.R.(eds.)2010.**Conservation Biology For All**. Online edn.Oxford University Press, Oxford.
4. Patiny,S.(ed)2012.**Evolution of Plant –Pollinator Relationships**,vol.18,The systematic Association Special. Cambridge University Press.Cambridge.

5. Dafni, A., Kevan, P.G. and Husband, B.C. 2005. **Practical Pollination Biology**, Enviroquest, Cambridge.
6. Bawa, K.S. & Hadley, M. (eds) 1991. **Reproductive Biology of Tropical Forest Plants**. vol. 7, Man and Biosphere Series. UNESCO, The Parthenon Publishing Co. Paris.
7. Shivanna, K.R. and Tondan, R. 2014. **Reproductive Ecology of Flowering Plants: A Manual**. Springer.
8. And many Research papers on Each Topic.

**Second Semester**  
**Theory (Generic Elective)**

**Paper Code: EMBCGE - 618**

**Paper ID- 03618**

**Paper Title – Animal Ecology and Behaviour**

**L T C Hours**

**4 0 4 48**

**Unit 1- Introduction to Animal Field Ecology**

Resource use (microhabitat and habitat, ideal free distribution, foraging behaviour: types, optimal foraging theory, game theory and feeding behaviour; resource defence); Life histories (approaches, trade-offs, major traits; human-induced selection); Community concept, structure and development; Invasion biology (relevance, processes, and impacts); Understanding biotic interactions (predator-prey and other animal-animal interactions, plant-animal interactions: pollination, pest management, seed dispersal, disease transmission).

**Unit 2 -Behavioural Ecology**

Darwinian puzzles and evolution of behavioural ecology; social organisation and behaviour, Altruism and kin selection, learning, communication strategies, parental care, sexual selection and mating strategies, time budget, thermoregulatory behaviour in cold-blooded animals, defence behaviour.

**Unit 3-Methodological Approaches in Animal Ecology and Conservation**

Methodological approaches for animal ecology and behaviour: transect method, quadrat method, scan animal sampling, focal animal sampling; applications of radio telemetry and radio collar studies.

**Unit 4 -Eco-evolutionary dynamics in Conservation**

Understanding eco-evolutionary dynamics and its integration to conservation: managing captive populations, predicting natural disasters, urban planning, designing conservation strategies, risk assessment wrt global climate change. Carrying capacity and ESS (Environmentally sustainable systems).

**Books recommended:**

Alcock, J. 2009. **Animal Behavior: An Evolutionary Approach**. Sinauer Associates, Inc., USA.

Boitani, L. & Fuller T.K. 2001. **Research Techniques in Animal Ecology: Controversies and Consequences**. Columbia University Press, 464pp.

Dawkins, M.S. 2007. **Observing Animal Behaviour: Design And Analysis of Quantitative Data**. Oxford University Press, USA.

Gotelli, N. 2001. **A Primer of Ecology**. Sinauer Associates, Inc., USA.

Krebs, C. J. 1999. **Ecological Methodology**. Addison-Wesley, New York.

Manning, A. & Dawkins, M.S. 2012. **An Introduction to Animal Behaviour**. Cambridge University Press, 458pp.

Mathur, M. 2005. **Animal Behaviour**. Rastogi Publications, Meerut, India.

**Second Semester**  
**Theory (Generic Elective)**

<b>Paper Code- EMBCGE-620</b>	<b>L</b>	<b>T</b>	<b>Credits</b>	<b>Hours</b>
<b>Paper ID- 03620</b>	<b>4</b>	<b>0</b>	<b>4</b>	<b>48</b>
<b>Paper Title –Environmental Stress Biology</b>				

**Unit I : Responses to physical environment:** Basic concepts of stress and strain; Different environmental stresses ; High and low temperature stress : chilling and thermal injury, thermotolerance, psychrotolerance ; Water stress : plant responses to water deficit and flooding; desiccation tolerance in microbes ; UV radiation effects: damage and repair , adaptive responses in plants.

**Unit II : Plant responses to gaseous environment:** Ecophysiological responses to enriched CO<sub>2</sub> environment; ecological significance of different CO<sub>2</sub> fixation pathways in plants; Physiological responses of plants to air pollutants- SO<sub>x</sub>, NO<sub>x</sub>, Ozone; Buffering capacity and Air pollution tolerance index of plants; Modelling photosynthetic responses of plants to environmental factors.

**Unit III : Plant Responses to chemical environment:** Salinity and alkalinity stress, effects of salts on plants, halophytes and non-halophytes, calcicoles and calcifuges, mechanisms of salt tolerance : Na<sup>+</sup>-K<sup>+</sup> exchange pump and ion regulation, compatible solutes, pH regulation, secondary metabolites; calcium signalling during abiotic stress; Heavy metals: Effects and toxicity to plants , mechanisms of metal tolerance, hyperaccumulators, phytochelatins.

**Unit IV : Animal response to stress environments:** Biological responses to high altitude and deep sea environment; Osmoregulation in fish, water conservation and adaptive mechanisms in desert habitats; hibernation and aestivation, Circadian rhythms and biological clock; Bioindicators and biomonitors of pollution.

**Books Recommended:**

1. Plant Physiological Ecology 2008. Lambers, Hans, Chapin III, F. Stuart, Pons, Thijs L., Springer
2. Plant Ecophysiology. 1996. (Ed) M.N.V Prasad. John Wiley & Sons
3. Physiological Animal Ecology 1996. Gideon N Louw. Prentice Hall
4. Physiology and Molecular Biology of Stress Tolerance in Plants. 2006. (Eds) K.V. MadhavaRao, A.S. Raghavendra, K. Janardhan Reddy. Springer.
5. Physiological Plant Ecology( Eds)Lange, O.A., Nobel,P.S., Osmond, C.B. and Ziegler, H. Encyclopedia( Vol. I-IV) Springer Verlag
6. Environmental Physiology of Plants. 2002. By Alastair H. Fitter, Robert K.M. Hay Academic Press
7. Animal Physiology: Adaptation and Environment 5<sup>th</sup> edition, 2002. By Knut Schmidt-Nielsen

**Second Semester**  
**THEORY (Generic Elective)**

Paper Code-EMBCGE-622

Paper ID-03622

Paper Title – Aquatic Ecosystems and Wetlands

L	T	Credits	Hours
4	0	4	48

**Unit 1: Introduction**

**Aquatic ecosystems:** Definitions, Fresh water (lentic, and lotic), marine and wetland ecosystems, classification of aquatic ecosystems and wetlands; chemical composition of fresh and marine waters.

**Ecology of aquatic ecosystems:** Elements of structure, functions and processes in fresh water (lakes and rivers), marine and estuarine ecosystems with respect to hydrology, productivity, and biodiversity; wetland soils types and redox potential; energy flow in aquatic ecosystems; stratification and zonation in rivers, lakes and oceans with respect to light, temperature, and pressure. Major environmental (abiotic and biotic) factors and ecosystem processes. Water quality and pollution of lakes, reservoirs, rivers, and marine waters.

**Unit 2: Fresh water ecosystems**

**Lakes and reservoirs:** Community organization, productivity, trophic levels and food webs; Bioassessment and biocriteria in lakes and reservoirs, index of biological integrity, eutrophication and trophic state index; biological adaptations, nutrient dynamics, methanogenesis, carbon cycle, climate change and impact on lakes and reservoirs; ecology of constructed wetlands.

**Rivers:** Types of rivers, geomorphology, longitudinal profile and classification of drainage network, rivers and ecological continuum, riparian and flood plain wetlands; river biodiversity, community organization; trophic structure and food webs; energy flow; negative and positive feedbacks and resilience.

**Unit 3: Marine & Estuarine ecosystems**

Structure and function of marine ecosystems; Case I & II waters, estuary types and genesis; organisms (plants, animals, microbes) in various ecological zones, community organization, productivity, nutrient cycling and dynamics, upwelling and downwelling of nutrients; mangroves, coral reefs; Biodiversity in Arctic and Antarctic oceanic environment.

**Unit 4: Aquatic biodiversity, ecosystem services and restoration**

Landscape ecological concepts; ecological restoration of fresh water and coastal ecosystems. Coastal regulation zone, International conventions & protocols: Ramsar Convention, Convention on Biological Diversity, Ramsar sites in India. Remote sensing and GIS in aquatic ecosystem management, biodiversity conservation, climate change and aquatic ecosystem response.

**Recommended Books/References**

1. Dobson, M. 2000. Ecology of Aquatic Management. Pearson Education
2. Singh, G. K. and Nautial, K. C. 2009. Biodiversity and Ecology of Aquatic Environment. Narendra Publishing House
3. Mitsch, W.J. and Gosselink, J.G. 2015. Wetlands, 4<sup>th</sup> edition, John Wiley & Sons. 744p.
4. Van Der Valk, A. G, and Arnoud Van Der Valk. 2012. The Biology of Freshwater Wetlands. Oxford University.
5. Raymundo E. R. 2008. Wetlands: Ecology, Conservation and Restoration. Nova Science

- Publishers Inc. 446p.
6. Keddy, P. A. 2010. Wetland Ecology: Principles and Conservation. Cambridge University Press, 516p.
  7. Dodds, W. K. 2002. Fresh Water Ecology-Concepts and Environmental Applications, Academic Press.
  8. Castro, Pand Huber, M.E. 2003. Marine Biology. 4<sup>th</sup> Edition. Mc-Graw Hill.
  9. <http://www.ramsar.org>
  10. Allan, J.D. and M.M. Castillo. 2007. Stream ecology: structure and function of running waters. 2nd Edition. Springer, NY, NY.
  11. Hauer, F.R. and G.A. Lamberti. 2007. Methods in Stream Ecology. 2nd ed. Academic Press, San Diego, CA.
  12. Merritt, R. W., K.W. Cummins and M.B. Berg. 2008. An introduction to the aquatic insects of North America (4th ed). Kendall Hunt Publishing Co.,
  13. Debuque, IA. Resh, V. H., and D.M. Rosenberg 1984. The ecology of aquatic insects. Praeger Publishers, New York, NY
  14. Brooks, K.N., P.F. Ffolliott, H.M. Gregersen and L.F. DeBano. 2003. Hydrology and the management of watersheds. 3rd Ed. Iowa State University Press,
  15. Ames IA. Gordon, N. D., B. L. Finlayson, T. A. McMahon, and C. J. Gippel. 2004. Stream hydrology: an introduction for ecologists. 2nd ed. Wiley, New York.
  16. Whitton, B. A. (Ed.) 1975. River Ecology. University of California Press
  17. Klein, L. 2013. Causes and effects: River Pollution. Elsevier publications
  18. Maltby, Edward, and Tom Barker 2009. The Wetlands Handbook, Wiley – Blackwell.
  19. Reddy, K. Ramesh, and Ronald D. Delaune 2008. Biogeochemistry of Wetlands: Science and Applications, CRC.
  20. Sigeo, D. C. 2005. Freshwater microbiology: biodiversity and dynamic interactions of microorganisms in the freshwater environment, John Wiley & Sons Ltd, England.
  21. Maltby, E. 2009. Functional assessment of wetlands - Towards evaluation of ecosystem services. Woodhead Publishing Limited, Cambridge, UK, 672p.

**Second Semester**  
**THEORY (Generic Elective)**

Paper Code- EMBCGE-624

Paper ID- 03624

Paper Title - Wildlife Biology

L	T	Credits	Hours
4	0	4	48

**Unit 1 -Introduction and History of Wildlife Conservation**

**Global as well as Indian Prospective:** Historical perspectives and its importance-direction and approach for conservation in present context. Concept of Protected Area Network (PAN), IUCN, CITES

**Values and Ethics in Wildlife Conservation:** Definitions and (Instrumental; Intrinsic; Ecocentrism; Religious traditions and conservation) Ethics in conservation.

**Unit 2 - Field ecology and methodology for wildlife monitoring:**

**Habitat Ecology:** Concept of habitat-microhabitat to Biosphere, Range, Area of occupancy, Niche and Resource Partitioning, Diversity indices.

**Field Techniques:** For invertebrates (planktons; insects/arachnids) and vertebrates (amphibian, reptile, Aves and mammals), Line/belt transects, Quadrat sampling, Point count, Scan sampling, Focal sampling, Time constraints sampling, Population indices, Introduction of Wildlife telemetry, Remotely triggered Camera Trapping Avian acoustics and identification based on calls.

**Wildlife Behaviour:** Sexual selection and conflict, Parental care and mating systems, Alternative reproductive strategies, Group living, selfishness and altruism; evolutionarily stable strategies; concept of optimality in decision making in animals; optimal foraging theory.

**Unit 3 -Avian ecology:**

Avian community ecology and habitat selection. Sexual selection in birds. Bird migration. Bird census techniques, Migratory flyways, threats to migrant populations.

**Sampling designs for population estimation:** Population estimation methods, Distance based Sampling Methods, Mark-Recapture for Closed Population, Indices, and Estimation of Demographic parameters.

**Unit 4- Current issues in wildlife conservation with case studies:**

Community based conservation approach, Impact of climate change on species diversity, Compensate payment for environmental services, Human-wildlife conflict, Poaching, illegal trading, Conflict management.

**Books Recommended:**

1. Bookhout, T. A. (1996). *Research and management techniques for wildlife and habitats* (5<sup>th</sup> Ed.). The Wildlife Society, Allen Press, Kansas, USA.
2. Buckland, S. T., Anderson, D. R., Burnham, K. P. and Laake, J. L. (1993). *Distance sampling-estimating abundance of biological populations*. Chapman & Hall, London, reprinted (1999) by Research Unit for Wildlife Population Assessment, St. Andrews.

3. Woodroffe R., Thirgood S. and Rabinowitz A. (2005). *People and Wildlife, Conflict or Co-existence?* (Conservation Biology) Cambridge University.
4. Caughley, G. (1977). *Analysis of vertebrate populations*. John Wiley and Sons, New York.
5. Caughley G. and Sinclair A.R.E. (Eds.) (1994) *Wildlife Ecology and Management*, Blackwell Science, Cambridge.
6. Hunter M.L., Gibbs J.B. and E.J. Sterling (2008) *Problem-Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
7. Rangarajan M. (2001) *India's Wildlife History*. Permanent Black, New Delhi, India.
8. Krebs, C. J. (1999). *Ecological Methodology* (2<sup>nd</sup> Ed.) Addison-Welsey Educational Publishers, Inc.
9. Sutherland, W. J. (2000). *The conservation handbook; research, management and policy*. Blackwell Sciences Ltd. London.
10. Sutherland, W. J., Newton, I. and Green, R. E. ((2004). *Bird Ecology and Conservation: A Handbook of Techniques*. Blackwell Sciences Ltd. London

## Second Semester

### Practical

Paper Code- EMBC-652

Paper ID-03652

Paper Title- Animal Taxonomy and Systematics Lab

P	T	Credits	Hours
4	0	2	4/wk

1. Collection and preservation techniques of animals.
2. Preparation of field data sheet
3. Identification of butterflies, amphibians and reptiles (up to the species), bats up to genus.
4. Documentation of Avifauna within the University campus and adjoining areas

## Second Semester

### Practical

Paper Code- EMBC-654

Paper ID-03654

Paper Title- Geoinformatics Lab

P	T	Credits	Hours
4	0	2	4/wk

1. Introduction to the software ERDAS Imagine 2010 and Arc GIS.

2. Digital Image Classification

- Supervised
- Unsupervised

3. Georeferencing

4. Mosaicing

5. Fusion (Merging of high and low spatial and spectral resolution images)

6. Subset image

7. Vectorizing and different functions of vector data using Arc GIS

8. GPS field data collection and import to computer / software

**Second Semester**  
**Practical**

**Paper Code- EMBC-656**

**Paper ID-03656**

**Paper Title- Phylogeny Lab**

<b>P</b>	<b>T</b>	<b>Credits</b>	<b>Hours</b>
<b>4</b>	<b>0</b>	<b>2</b>	<b>4/wk</b>

1. Selection, character analysis, clustering, cladogram construction and analysis
2. Database retrieval techniques from major databases by NCBI and EBI (Gene bank and other tools)
3. Molecular phylogeny and sequence analysis using major bio-tools (MEGA-5 )
4. Primer designing using Primer-3 and degenerate primer using Clustal W.
5. Boot strapping using MEGA 5
6. Molecular identification using BLAST and DNA Barcoding.

## Third Semester

### THEORY

Paper Code- EMBC-701

L T Credits Hours

Paper ID-03701

4 0 4 48

Paper Title – Biodiversity Conservation, Human Society and Ethics

#### **Unit I – Sustainability**

Humans and sustainability - An overview, Sustaining key resources: Food, soil and pest management, Sustaining water resources, Energy efficiency and renewable energy, Environmental problems, their causes and sustainability

Sustaining biodiversity - Sustaining biodiversity: The Species Approach, Sustaining Terrestrial biodiversity: The Ecosystem Approach, Sustaining Aquatic biodiversity: The Ecosystem Approach  
Sustaining Human societies - Nature and society, Sociology of environmental knowledge, Sensitivity towards sustaining nature, Environmental/Conservation Ethics

#### **Unit 2 - Economics and biodiversity**

Ecosystem services and biodiversity conservation, Economic valuation of environmental goods, Cost and benefits of land use conversion, Measuring benefits and loss, Economic values and moral issues

Methodologies of Economic valuation - A classification of valuation procedures, The direct valuation approach, The indirect valuation approach, Conventional market approaches, Choice of valuation techniques

Case studies on economic evaluation of Yamuna floodplains, New Delhi, Loktak Lake, Manipur, Nakki Lake, Nainital, Medicinal plants

#### **Unit 3 – Biodiversity and Human Health**

Biodiversity Loss and implication for human health - Causes and consequences of biodiversity loss, Ecosystem disturbances and their effects on infectious diseases, Vector, pathogen and host diversity and human infectious disease, Climate change and its effect on infectious disease

Medicines from nature - History of natural products as medicines, Role of traditional medicine in drug discovery, Potential medicines in food, Natural medicines as insecticides and fungicides

#### **Unit 4 - Biodiversity and Traditional Health Systems**

Indigenous people and conservation, Significance of traditional ways of life, Ethno-biology and Ethno-pharmacology, Benefits from Ethno-botanical discoveries for native communities, Opportunities for collaboration between biomedical and conservation communities,

Biodiversity and human dimension- Cultural and biological diversity, Indigenous movement and conservationists, Conservation through self-determination, Green consumerism, Conservation education, Integrated conservation and development

**Books Recommended:**

1. Miller, G. T. and Spoolman, S. 2011. Living in the environment. Cengage learning
2. Pearce, D. W. and Moran, D. 1994. The Economic value of Biodiversity. Earthscan Publishers
3. Kontoleon, A., Pascual, U and Swanson, T. 2007. Biodiversity Economics: Principles Methods and Applications. Cambridge University Press
4. Chivian, E and Bernstein, A. 2008. Sustaining life: How human health depends on biodiversity. Oxford university press
5. Macnaghten, P and Urry, J. 1998. Contested Natures. SAGE publications Ltd.
6. Mulder, M. B. and Coppolillo, P. 2004. Conservation: Linking Ecology, Economics and Culture. Princeton University Press
7. Tellegen, E and Wolsink, T. (Eds.) 1998. Society and its Environment. Routledge Press
8. Wood, P. M. 2000. Biodiversity and democracy: rethinking society and nature. University of British Columbia Press.
9. Grifo, F. and Rosenthal, J. 1997. Biodiversity and Human Health: Implications for human health. Island Press
10. Groom, M. J., Meffe, G. R. and Carroll, C. R. 2006. Principles of Conservation Biology, Sinauer Associates, Inc., USA.

## Third Semester

### THEORY

Paper Code- EMBC-703

Paper ID-03703

Paper Title – Conservation Policies and Law

L	T	Credits	Hours
4	0	4	48

#### **Unit 1: Protection of Forest and Wildlife**

Forest Law in India - Forestry in British and Post British India, Forest as a source of Revenue, Forest Protection and Sustainable use of Forests: Judicial Perspective ,The Indian forest Act, 1927, The Forest (Conservation) Act, 1980, The Forest (Conservation) Rules, 1981,2003, The Environment (Protection) Act, 1986, Ozone Depleting Substances (Regulation) Rules, 2000  
Wildlife laws in India - The Wildlife (Protection) Act, 1972; The Wildlife (Protection) Rules, 1995; The Wildlife (Protection) Amendment Act, 2002 , Preservation and Management of wildlife in India: Court Decisions; Ecotourism and Forest Protection

#### **Unit 2: Biodiversity and Patent**

The Biological Diversity Act, 2002; Biological Diversity Rules, 2003; Brief idea of Patents, CopyRight, Trade Mark and Trade-related aspects of Intellectual Property (TRIPS); Eco-Labeling notifications and DNA bar-coding; The Protection of Plant Varieties and Farmers' Rights (PVPFR) Act, 2001,2007; Environmental Impact Assessment Notifications

#### **Unit 3: Laws Concerning Forest, Wildlife and People**

The Circular Concerning Joint Forest Management, 1990; Panchayats (Extension to Scheduled Areas) PESA Act, 1996; Forest Right Act, 2006; Recognition of ZOO Rules, 1992; International Laws and Polices Concerning Biodiversity; Gaps in Present Laws and Polices with respect to Biodiversity Conservation

#### **Unit-IV: International Law and Constitutional Frame for Conservation Policies**

United Nations Framework Convention on Climate Change, Convention on Bio-Diversity-1992, Kyoto Protocol and Emission Trading, Post Kyoto World: Problems and Prospects.  
Constitutional Provisions relating to Environment and Conservation Policies, Evolution of Environmental Rights through judicial process, Human Rights and Bio-diversity Protection interface.

#### **Books Recommended:**

1. **A. Rosencranz and S. Divan. 2004.** Environmental Law and Policy in India: Cases, Materials and Statutes. Oxford University Press, New Delhi.
2. **Sahasranaman, P. B. 2009.** Handbook of Environmental Law. Oxford University Press, New Delhi, India.
3. **Singh, Chhatrapati. 2000.** India's Forest Policy and Forest Laws. Natraj Publishers, Dehradun, India.
4. **Biswas, S. K. 1988.** Forest Administration in India. Cough Publications, Allahabad, India.

5. **Dogra, B. 1983.** Forests and People: A Report on the Himalayas. Bharat Dogra, New Delhi.
6. **Jain, A. K.** Forest Economy of India (A case study of Balaghat District of Madhya Pradesh). Vohra Publishers, Allahabad.
7. **Upadhyay, C. B.2001.** Forest Laws: Central and States. Hind Publishing House, Allahabad, India.
8. **P. Leelakrishnan. 2004.** Environmental Law Case Studies. LexisnexisButterworths, Nagpur, India.
9. **P. Leelakrishnan. 2004.** Environmental Law in India. LexisnexisButterworths, Nagpur, India.
10. **Mohan. I. 2002.** Environment and Habitat. Anmol Publications Pvt. Ltd., India.
11. **Dutta, R. and B. Yadav. 2005.** Supreme Court on Forest Conservation. Universal Publishing House, Delhi.
12. **Bandyopadhyay, J.** 2005. India's Environment: Crisis and Responses. Natraj Publisher, Dehradun.
- 13.--Boyle and Birnie.** 1995. Basic Documents on International Law and Environment

The following **important cases**

14. RLEK vs. Union of India, AIR 1988 SC 2187, 2199
15. Indian Council of Enviro-Legal Action v. Union of India, AIR 1996 SC 1446
16. Vellore Citizen's Forum v. Union of India, AIR 1996 SC 2715
17. A P Pollution Control Board v. Prof. M V Nayudu, AIR 1999 SC 812
18. MC Mehta v. Kamalnath 1997 (1) SCC 388

## Third Semester

### THEORY

Paper Code - EMBC- 705

Paper ID- 03207

Paper Title: Development Communication in Conservation

L	T	Credits	Hours
4	0	4	48

#### **Unit 1:- Introduction to Social and Scientific writing**

Historical perspective, Ethics in scientific publishing, need for development communication

#### **Orientation to writing for publications:**

Orientation to writing articles for general public; communication through Conference short term papers, theses, and dissertations ;Writing short non-research papers , review articles, original Research papers, Avoiding Plagiarism; Preparation of a poster; Compilation of conference report; Organizing a workshop, seminar, conference.

**Preparation of talks:** Oral paper presentation with/without audio –visual support;

Power Point Presentations, Scientific talks, Community talks

#### **Unit 2: Orientation to prepare a research Proposal**

Approach of writing a proposal, Developing initial idea, Orientation to proposal writing, Understanding the nature and philosophy of the agency and funding environment, Need based program development, Writing the needs or problem statements, Writing the goals, objectives and implementation, Writing the evaluation plan, Budgeting and utilization, Agency capability and finishing touches.

#### **Orientation to prepare a research Project**

#### **Preparation of Technical Reports**

**Unit 3: Communication:** Definition & Functions, Elements and steps, Barriers of Communication, Types of Communication: Verbal and Nonverbal, Intrapersonal, Interpersonal, Group and Mass Communication, Characteristics and differences between various types, Definition, Elements and Functions of Mass Communication

Channels of Mass Communication: Print, Radio, Television, Film, Video, New Media

**Unit 4: Development:** Definition, Meaning, Paradigms, Indicators, Changing concepts,

Development communication: Definition and Concept

Various Approaches to Development Communication: Participatory Communication approach; Development Support Communication – Extension, Biodiversity, Conservation and development, Communication for Biodiversity and Conservation

#### **Books Recommended:**

1. Robert A. Day & Barbara Gastel, 2006. How to write and publish a scientific paper; 6th Edition; Cambridge University Press.
2. Soraya M. Coley & Cynthia A. Scheinberg 2001. Proposal Writing; Sage Publication.
3. Jacobson S. K. 2009. Communication Skills for Conservation Professionals, Island Press; Second Edition, USA

4. Jacobson S. K., McDuff M. D. & Monroe M. C. 2006. Conservation Education and Outreach Techniques (Techniques in Ecology & Conservation). Oxford University Press, UK
5. Corbett J. B. 2006. Communicating Nature: How We Create and Understand Environmental Messages. Island Press; 2<sup>nd</sup> Edition.

**Third Semester**  
**THEORY**

**Paper Code- EMBC-707**

**Paper ID-03707**

**Paper Title – Biostatistics**

<b>L</b>	<b>T</b>	<b>Credits</b>	<b>Hours</b>
<b>4</b>	<b>0</b>	<b>4</b>	<b>48</b>

**Unit 1:** An overview of environmental systems, Basic definitions and applications, Generation of environmental data; Types and objectives of environmental studies; Random processes, Stochastic processes in the environment; Significance / relevance of data analysis

**Unit 2:** Sampling representative sample size, sampling bias and sampling techniques. Data collection and presentation: Types of data, methods of collection of primary and secondary data; Methods of data collection; Methods for selecting sampling locations and times; Simple random sampling, Stratified random sampling, Systematic sampling; Sample size determination ; Determination of sample size for simple comparative experiments, determination of sample size to obtain a confidence interval of specified width; Construction and labelling of graphs; Graphical representation by histogram, polygon and pie diagram;, histogram, piecharts, scatter plots.

**Unit 3:** Measures of central tendency; Mean, median, mode; Sampling distributions of - Means, Difference of means, Proportion, Variances , Covariance; Estimation of parameters: Point and Interval estimates; Measurement of the spread of data-range; Variation of mean, standard deviation, variance, coefficient of variation, standard error of mean; Confidence interval estimation of - Means, Difference of means; Correlation and regression: positive and negative correlation and calculation of KarlPearsons co-efficient of correlation; Linear regression and regression equation, Calculation of an unknown variable using regression equation ; ANOVA, one and two way classification

**Unit 4:** Tests of Hypotheses: Null and Alternative Hypothesis; Type I and Type II Errors; Level of significance; Parametric tests (Concerning Means, Difference of means, Proportion, Variances): Tests of significance for large samples: Z test , Types of Z test (one sample and two sample) , Standard error for Z test ; Tests of significance for small samples: T-test (One sample, Two Sample: Independent and Dependent), Standard error for T-test ; F-test for comparison of variance ; Goodness-of-fit test – Chi-Square test; Test for quality of data: Qtest ; Nonparametric tests – Sign test, Wilcoxon Signed Rank test , Kruskal-Wallis test

**Books Recommended:**

1. Wayne W.D 2004. Biostatistics: A foundation for Analysis in the Health Sciences, 8th Edition, Wiley.
2. Mann, P.S. 2006. Introductory Statistics, 6th Edition, Wiley.
3. Rice, J. A. 2006. Mathematical Statistics and Data Analysis, 3rd Edition, John A. Rice, Duxbury Press.

4. Keith, L.H. (Ed.) 1988. Principles of Environmental Sampling ACS Professional References, American Chemical Society.
5. Berthouex, P.M. and Brown, L.C. 1994. Statistical for Environmental Engineers. Lewis Publishers, CRC Press.
6. Johnson, R.A. 1999. Miller & Freund's Probability and Statistical for Engineers (5th edn). Prentice-Hall of India Pvt. Ltd.: New Delhi.
7. Walpole, R.E. and Myers, R.H. 1985. Probability and Statistics for Engineers and Scientists (3rd edn). Macmillan Publishing Company: New York.

**Third Semester**  
**PRACTICAL**

Paper Code- EMBC-751

Paper ID-03751

Paper Title – Conservation Communication Lab

P	T	Credits	Hours
4	0	2	4/wk

**1. Planning campaign for biodiversity conservation**

- Setting objective
- Target audience identification and segmentation
- To develop communication strategy
- To develop message strategy
- Creative production execution
- Dissemination of the message
- Evaluation of the campaign

**2. Preparing AV/video clipping /photo feature based on campaign or field study**

**3. Visit to pre-identified area outside Delhi to study socio-cultural background of community/ cultural zone to monitor status of conservation and biodiversity in area under study**

- Study of climate / topography/flora-fauna in the perspective of biodiversity conservation
- Preparing comprehensive report on the study and include visuals / graphics if required
- Design the content of the report and publish it in hard copy print and for the website.

**Third Semester**  
**PRACTICAL**

Paper Code- EMBC-753

Paper ID-03753

Paper Title – Web Designing Lab for Conservation

P	T	Credits	Hours
4	0	2	4/wk

1. Introduction to Internet and HTML
2. Importance of Website in disseminating information on Biodiversity and Conservation
3. General principles of web design
4. HTML Page Structure
5. Usage of Head & Body tags
6. Working with images, tables and hyperlinks
7. Defining Web Layout and its usability
8. Basics concept of CSS
9. Creating Website and Web pages
10. Project report
11. Presentation/Viva voce

## Third Semester

### PRACTICAL

Paper Code- EMBC-755

Paper ID-03755

Paper Title – Biostatistics and computer applications lab

P	T	Credits	Hours
4	0	2	4/wk

1. To determine the descriptive statistics for the data set.
2. To construct Box plot, Individual value plot and histograms for the given data set and interpret the same.
3. To develop null and alternate hypothesis.
4. To understand the concept of standard error and confidence interval.
5. To understand sampling distributions and find central tendency.
6. To conduct one sample and two sample Z-test.
7. To conduct a t-test and interpret using standard values.
8. To conduct one sample T-test
9. To conduct two sample T test
10. To conduct a paired T-test to evaluate two test procedures and dependent data sets.
11. To check for bias and significance of results for T-test
12. To carry out non parametric Mann WhitneyTest for a sample.
13. To evaluate correlation between two parameters at various significance level.
14. To find a regressive coefficient and fit a linear model for a problem

**Third Semester**  
**Theory (Open Elective )**

Course Code: **EMOE-731**

Course Title: **Climate change mitigation & adaptation**

**(L:4) (C:4)**

**UNIT-I**

**Basic concepts and mechanisms:** Science of climate change, global warming and greenhouse effect, radiative balance, earth's carbon reservoirs and carbon cycle, El-Nino and La Nino, greenhouse gases in the atmosphere – sources, levels and mechanisms of action.

Effects: Rise in earth's temperature; effects on forests; effects on agro ecosystems; desertification; effects on freshwater ecosystems; effects on oceans; sea level rise; melting of polar ice and glaciers; effects on rainfall patterns; extreme events, socio-economic and public health consequences.

**UNIT-II**

**Climate Change Policy-Mitigation:** Carbon storage and sequestration, carbon management through a biotic sequestration; oceanic and geologic injection, scrubbing and mineral carbonation; carbon management through biotic sequestration; forest ecosystems, wetlands; soil carbon sequestration; bio fuels, carbon farming and carbon trading

**UNIT-III**

**Climate Change Policy – Adaptation:** Climate change impact assessment – applications for agriculture, sea level rise and health; vulnerability assessment; economics of adaptation, measurement of adaptation cost; issues in financing adaptation; case studies  
The Indian scenario: Projected impact of climate change on India; temperature, rainfall, forests, agriculture, water resources; India's response to climate change; National Action Plan on climate change; India's position and actions vis-a-vis international programmes (UNFCCC, CDM and Kyoto Protocol, REDD+, Copenhagen Accord, etc.).

**UNIT-IV**

International response: Intergovernmental panel for climate change (IPCC) and its role; United Nations framework convention on climate change (UNFCCC), CDM and Kyoto Protocol; the bali road map; The Copenhagen Accord; future actions; ethics of climate change.

**Text Books:**

1. J. T. Hardy, 2003, *Climate Change: Causes, effects and solutions*, John Wiley and Sons
2. Egbert Boeker and Rienk van Grondelle (2013). *Environmental Science Physical Principles and Applications*, John Wiley & Sons, Ltd., New York

**References:**

1. AkimasaSun, Kensuke, F., and Ai, Hiramatsu.(2010). *Adaptation and mitigation strategies for climate change*. Springer.

2. Gautam, P.L. Singh, V. and Melkania, U. (Eds.). (2009). Ecosystem diversity and carbon sequestration: climate change challenge and a way out for ushering in a sustainable future. Daya Publishing House, Delhi.
3. Ravindranath, N.H., Ravindranath, N. and Sathaye, J.A. (2002). Climate change and developing countries. Kluwer Academic Publishers.
4. Sarkar, A.N. (2010). Emissions trading and carbon management. Pentagon earth.
5. Burroughs, W.J. (2007). Climate change: A multidisciplinary approach (2nd edition.). Cambridge University Press. Dash,
6. Sushil Kumar. (2007). Climate change: An Indian perspective. Cambridge University Press India pvt.ltd. New Delhi.
7. IPCC, (2007): Summary for policymakers. In: Climate change 2007: impacts, adaptation and vulnerability. Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 7-22.
8. S. Singh, *Trace Gas Emission and Plants*, Kluwer Academic Publishers, 2000
9. Stern, N., *The economics of climate change – The Stern Review*, Cambridge University Press, 2006.
10. Nordhaus, W.D., *Managing the Global Commons: The Economics of Climate Change*, MIT Press, 1994.
11. Toman, M.A., U. Chakravorty, and S. Gupta, *India and Global Climate Change: Perspectives on Economics and Policy from a Developing Country*, RFF Press, 2003.

**Third Semester**  
**Theory (Open Elective )**

Course Code: EMOE-733

Course Title: **DISASTER RISK REDUCTION AND MANAGEMENT**

**(L:4) (C:4)**

**UNIT-I**

**Introduction:** Concepts and definitions of Hazard, disaster, vulnerability, resilience, and risks; classification of disasters; brief introduction of Geological Disasters (earthquakes, landslides, tsunami, mining), Hydro-Meteorological Disasters (floods, cyclones, lightning, thunderstorms, hail storms, avalanches, droughts, cold and heat waves); Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Man-made Disasters (building collapse, rural and urban fire, road and rail accidents); Global Disaster Trends – Emerging Risks of Disasters; Climate Change and Urban Disasters

**UNIT-II**

**Disaster Management Cycle, Risk Reduction and managing risks**

Disaster Management Cycle; Principles of risk management, hazard and vulnerability mapping and analysis (physical, social, organizational, economical, technological). Developmental projects (dams, power plants etc.) and risk management; Evacuation, Communication, Search and Rescue; Emergency Operation Centre – Incident Command System; Relief and Rehabilitation; Post-disaster Damage and Needs Assessment; Restoration of Critical Infrastructure; Early Recovery – Reconstruction and Redevelopment;

**UNIT-III**

**Disaster Risk Reduction tools and capacity building**

**Prevention and Mitigation of Disasters,** Early Warning System; Preparedness, adaptive ecosystems management for disaster risk reduction; awareness during Disasters; Geoinformatics in Disaster Management (RS, GIS, GPS); Disaster Communication Systems (Early Warning and Its Dissemination); Land Use Planning and Development; Disaster safe designs and constructions; Structural and Non Structural Mitigation of Disasters; Disaster Risk Transfer and Financing; role of print and electronic media during disasters. Community based disaster risk reduction. Health issues and hospital preparedness and response; System approach in disaster management;

**Disasters and Ecosystems:** Climate change and ecosystems based management for disaster risk reduction and resilience;

**UNIT-IV**

**Disaster Management in India**

Disaster Management in India; Disaster Management Act 2005; National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies; National Disaster Management Authority (NDMA); NIDM (National Institute of Disaster Management), State Disaster Management Authorities, National Disaster Response Force; Institutional arrangement during disasters; **International Agencies**

(International Space Charter, UNISDR); International Strategy for Disaster Reduction; Hyogo Framework (2005-2015); Sendai Framework (2015-2030); S&T Institutions for Disaster Management in India;

**Text Books:**

1. BimalKanti Paul (2011). Environmental Hazards and Disasters-Contexts, Perspectives and Management, John Wiley & Sons, 332p.
2. Fabrice G. Renaud, Karen Sudmeier-Rieux and Marisol Estrella (Ed)(2013). The role of ecosystems in disaster risk reduction, *United Nations University Press, 2013,*

**Reference Books:**

1. Jack Pinkowski (Ed.) (2008). Disaster Management Handbook, CRC Press -Taylor & Francis Group, 595p.
2. Joseph F. Gustin (2010). Disaster & Recovery Planning: A Guide for Facility Managers, 5th Edition, Taylor & Francis., 436p.
3. Thomas D. Schneid and Larry Collins (2001). Disaster Management and Preparedness,
4. Lewis Publishers, 247p.
5. Vlasta Molak (Edited) (1997). Fundamentals of Risk Analysis and Risk Management, Lewis Publishers, 451p.
6. Yacov Y. Haimes (2009). Risk Modeling, Assessment and Management, Third Edition, A John Wiley & Sons, Inc. Publication, 1033p.
7. Gupta, Anil. K. and Sreeja S. Nair (2011). Environmental Knowledge for Disaster Risk Management, National Institute of Disaster Management, New Delhi
8. Govt, of India (2005). Disaster Management Act 2005.
9. Publications of National Disaster Management Authority (NDMA), and National Institute of Disaster Management (NIDM).

**Third Semester**  
**Theory (Open Elective )**

**Paper Code- EMOE-735**

**Paper Title - Urban Biodiversity Strategies for Conservation**

**(L:4) (C:4)**

**Unit 1 - The Urban Ecosystem: An Introduction to Novel ecosystems in the Anthropocene**

What is Urban? What is Urban Ecology? Cities as Human and Ecological Systems, **Global and Local Patterns of Urbanization**, Exo-urbanization, Suburbanization, New town , Disurbanization (or counter-urbanization), Reurbanization, Slums, Shanty Towns Urban climate and climate change- Urban Soil and Water, **Heat Island Effect Social and ecological urban systems**

**Unit 2 - Urbanization and Biodiversity**

Biogeography and biodiversity of anthromes and novel ecosystems, **Biodiversity within urbanized areas, Urban Ecosystem Services, Impacts of Urbanization on Biodiversity**, Positive Impact on Biodiversity, Extinction and urbanization Urban Species and Communities: **Native Species , Non-native species** Urbanophilic, Urbanophobic, Synanthropic, Archatypes, Neotypes, Impacts of Non-native/invasive/exotic species , Biotic Homogenization and Differentiation

**Unit 3 - Conservation in Urban Areas**

**Urban Planning and Restoration, Reconciliation ecology, Urban planning and green infrastructure: Green roofs; Green spaces; Gardening/ Landscaping; Living walls; Vertical Gardening**  
**Singapore/City Biodiversity Index, Biophilic Cities, Resilient Cities, Sustainable Cities, Green Delhi Movement in NCT of Delhi**

**Unit 4 - Urbanization and Human Well Being**

**Convention On Biodiversity and Conservation - National Biodiversity Strategy and Action Plan, Local Biodiversity Strategy and Action Plan Guidelines**, Diseases in urban Environment, Shaping cities for health: complexity and the planning of urban environments in the 21st century, **Cities and Biodiversity Outlook Assessment Report**, Conservation Education, Conservation and Society, Future Strategies for Urban Biodiversity

Suggested Reading:

1. Hobbs, R. J., E. S. Higgs, and C. M. Hall, (eds. 2013). **Novel ecosystems: intervening in the new ecological world order**. John Wiley & Sons, Chichester, UK.
2. Wiley & Sons, Chichester, UK. Hobbs, R. J., E. Higgs, and J. A. Harris. 2009. Novel ecosystems :implications for conservation and restoration. *Trends in Ecology & Evolution* 24:599-605.
3. Kowarik, I. 2011. Novel urban ecosystems, biodiversity, and conservation. *Environmental Pollution* 159:1974-1983.

4. Pickett et. al. 2008. Beyond Urban Legends: An Emerging Framework of Urban Ecology, as Illustrated by the Baltimore Ecosystem Study. *Bioscience* 58(2): 139-150.
5. Pickett, S.T.A. and J.M. Grove. 2009. Urban Ecosystems: What would Tansley Do? *Urban Ecosystems* 12: 1-8.
6. Alberti et al. 2003. Integrating Humans into Ecology: Opportunities and Challenges for Studying Urban Ecosystems. *Bioscience* 53(12): 1169-1179..
7. Adams LW. 1994. **Urban Wildlife Habitats**. Minneapolis: University of Minnesota Press.
8. Gilbert OL. 1989. **The Ecology of Urban Habitats**. London: Chapman and Hall.
9. Ellis, E.C. 2013 Sustaining biodiversity and people in the world's anthropogenic biomes *Current Opinion in Environmental Sustainability*, 5:368–372
10. Dallimer M., Irvine K.N., Skinner A.M.J., Davies Z.G., Armsworth P.R., Rouquette J.R., Maltby L.L., Warren P.H., Gaston K.J. (2012). Biodiversity and the feel-good factor: understanding associations between self-reported human well-being and species richness. *BioScience* 62: 47-55
11. Hughes J., Pretty J., Macdonald D.W. (2013). Nature as a source of health and well-being: is this an ecosystem service that could pay for conserving biodiversity? In: **Key Topics in Conservation Biology** (eds. D.W. Macdonald, K.J. Willis). John Wiley & Sons Ltd, Chichester

## Third Semester Theory (Open Elective)

Paper Code: EMOE-737

Paper title – Human aspects of Biodiversity and Environment

(L:4) (C:4)

### **Unit 1: Linking biodiversity, environment and human being**

Basic concept of biodiversity and environment: Biotic and abiotic factors, biodiversity and its components; How biodiversity and environment affects human well-being; case studies from historical perspectives and current scenario; Factors that affect human perceptions about biodiversity and environment

### **Unit 2: Understanding human aspects of biodiversity and environment**

Socio-cultural diversity, ethnic diversity, linguistic diversity; Sacred groves and sacred landscapes; Understanding ecological services; Understanding how local biodiversity and environment affects human life (wrt local plants and animals, pesticide use vs agricultural pests, handling native vs. exotic sp, urban biodiversity and urban planning).

Understanding different missions related to human aspects of biodiversity and environment: 'Swachh Bharat Abhiyan', 'Clean Ganga' and 'Clean-Yamuna' campaign, 'Save Tiger', 'Save Culture', 'Save Forest', 'Protect Wetlands' 'Decade on Biodiversity'.

### **Unit 3: Concepts and applications related to human aspects of biodiversity and environment**

Concept of Indigenous Knowledge Management and benefit sharing with case studies;

Biomimicry; Ecotourism and Eco-taxation; Eco-designing, Conservation education, Environmental journalism

### **Unit 4: Addressing issues related to human aspects of biodiversity and environment**

Ethical issues related to biodiversity and environment; Pro and cons of ban on animal dissection; Issues related to GM crops and Vertebrate pest management; Practising sustainability for a better future

### ***Books recommended:***

1. Miller, G.T. and Spoolman, S. 2011. Living in the environment. Cengage Learning.
2. Pearce, D.W. and Moran, D. 1994. The Economic Value of Biodiversity. Earthscan Publishers.
3. Wood, P.M. 2000. Biodiversity and democracy: rethinking society and nature. University of British Columbia Press.
4. Groom, M.J., Meffe, G.R. and Carroll, C.R. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
5. Primack, R. 2006. Essentials of Conservation Biology. Sinauer Associates, Inc., USA.

## Third Semester Theory (Open Elective)

Course Code: EMOE- 739

Course Title: **Corporate Social Responsibility**

**(L:4) (C:4)**

### UNIT-I

**Concept of CSR:** What do you mean by CSR? New Company Law in India: Doing Business with the Compulsory CSR. Business ethics and society in India, role of public policy in promoting CSR and sustainability, benefits of CSR programme; global principles and guidelines; The Companies Act, 2013 critical analysis, disclosure of CSR activities made compulsory, Mutual Co-existence: CSR and ensuring environmental sustainability.

### UNIT-II

#### Scope of CSR across key sectors

Rural development and CSR, CSR initiatives being taken by selected public and private Indian companies for rural development; The Impact of CSR Programs on socio-economic development of Rural Poor. Greening environment. Role of NGOs and community. Health care development and CSR, CSR initiatives being taken by selected public and private Indian companies; The Impact of CSR Programs for clean India mission. Role of CSR in the area of Education, CSR initiatives being taken by selected public and private Indian companies;

### UNIT-III

**CSR Planning and Institutionalising :** Institutionalizing CSR –various steps, corporate governance practices, Indicators for measuring impacts, multi-stakeholder approach. Addressing Issues and challenges of CSR in India- sustainability, corporate disclosure, motivation for companies, investors' pressure, visibility factor, transparency, operating cost, duplication of work, alliance of industries for CSR, Corporate social reporting.

### UNIT-IV

**CSR based case discussion: Topic focus:** concept, theory, approach, application and impact

- Green Business : Addressing Sustainable development
- Serving the world's poor profitably
- National Practice CSR case example
- Global best practice case example

#### Text Book:

1. Blowfield M, and Murray A 2008 Corporate Social Responsibility: A critical Introduction . Oxford University Press. USA

2. Bhattacharya, CB; Sen, Sankar; Korschun, Daniel (2011). Leveraging Corporate Social Responsibility: The Stakeholder Route to Business and Social Value. Cambridge: UK: Cambridge University Press.

**Reference Books:**

Visser, W.; Matten, D.; Pohl, M.; Tolhurst, Nick (2008). The A to Z of Corporate Social Responsibility. Wiley. ISBN 978-0-470-72395-1.

Kerr, M.; Janda, R.; Pitts, C. (2009). Pitts, C., ed. Corporate Social Responsibility: A Legal Analysis. Toronto: LexisNexis. ISBN 978-0-433-45115-0.

Philip Kotler and Nancy Lee (2005) Corporate Social Responsibility: Doing the Most Good for Your Company and Your Cause by Sage Publication.

Sanjay K Agarwal (2008) Corporate Social Responsibility in India. Sage Publication.

## Third Semester Theory (Open Elective)

Course Code: **EMOE-741**

Course Title: **Sustainable Ecotourism**

**(L:4) (C:4)**

### **UNIT-I**

**Concept of Ecotourism:** Definitions, ecotourism, difference between tourism, examples various forms, development of ecotourism in India and outside. Ecological, social and economic dimensions of ecotourism, eco-tourists, linkages with local culture, ethics and livelihoods, stakeholders' analysis, threats due to large scale ecotourism.

### **UNIT-II**

**The ecotourism perspectives:** High value may also be high impact, bulk ecotourism and problems, stakeholder challenges. Ecotourism Policy and practices, national policy frame work, example – Madhya Pradesh & Uttarakhand State case. Successful ecotourism initiative, Criteria and Indicators for sustainable Ecotourism. Ecotourism certification, Accreditation of eco-lodges and resorts .

### **UNIT-III**

**Ecotourism alternative services and Ecotourism Products:** sustainable extraction, extraction impacts, community involvement and compensation, shift from consumption to sustainable management. Concept of carrying capacity and factors. Designing ecotourism products and their relevance to ecology and livelihood, benefit sharing, capacity building of locals.

### **UNIT-IV**

**Case studies and analysis:** Ecotourism in protected areas of India and abroad,

- Mangrove area and biodiversity conservation through ecotourism,
- Ecotourism in coastal areas
- Mountain area ecotourism in Sikkim
- Herbal ecotourism in Kerala,
- Wildlife area ecotourism.

#### **Text Books:**

1. Honey, Martha. 2008. Ecotourism and Sustainable Development: Who Owns Paradise? 2<sup>nd</sup> edition. Island Press.
2. Jennifer Louise Hill, Tim Gale 2005 Ecotourism and Environmental Sustainability: Principles and Practice. Ashgate Publishing Company. USA

#### **Reference Books:**

1. Patterson, Carol, Delia Owens, and Mark Owens. 2007. The Business of Ecotourism. Trafford Publishing.

2. Collier, Paul and Anthony J.J. Venables. 2011. Plundered Nations? Successes and Failures in Natural Resource Extraction. Palgrave MacMillan.
3. Seema Bhat & Syed Liyakhat 2008. Ecotourism Development in India: Communities, Capital and Conservation published by CEE, Ahmedabad.