GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY
Sector – 16C Dwarka, New Delhi – 110078
(Coordination Branch)

F.No. IPU/JR(C)/44th AC/2018/454 **Dated:04/07/2018**

Circular

The 44th meeting of the Academic Council of the University was held on 03/05/2018. Please find enclose herewith the proceedings of the 44th meeting of the Academic Council for kind information.

(Registrar)
coordination112@gmail.com

F.No. IPU/JR(C)/44th AC /2018/ **Dated:04/07/2018**

1) All Deans and Directors of Guru Gobind Singh Indraprastha University
2) Prof. Sanjiv Mittal, Professor, University School of Management Studies
3) Prof. U.K. Mandal, Professor, University School of Chemical Technology
4) Prof. Udayan Ghose, Professor, University School of Information Communication & Technology
5) Dr. Nimisha Sharma, Associate Professor University School of Biotechnology
6) Dr. Gulshan Kumar, Asst. Professor, University School of Basic and Applied Science.

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

(Registrar)
coordination112@gmail.com

GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

SECTOR – 16 C, DWARKA, NEW DELHI - 110078

GURU GOBIND SINGH
INDRAPRASTHA
UNIVERSITY

FORTY FOURTH MEETING OF THE ACADEMIC COUNCIL

DATE : 03rd May, 2018 (Thursday)

TIME : 03.30 P.M. Onwards

VENUE: (Conference hall, Vice Chancellor's Secretariat)

PROCEEDINGS OF 44th ACADEMIC COUNCIL MEETING

INDEX OF PROCEEDINGS

10	AC44.10	To ratify (i)Syllabus of M.Tech. (Bio Chemical Engg.) for B.Tech./M.Tech.(Bio-Chemical Engineering/Dual Degree Programme (ii) minor modification of Chemical Engg. Courses, being taught at the University School of Biotechnology for B.Tech. (Biotechnology) students, implemented from the Academic Session 2017-2018.	11
11	AC44.11	To consider and approve the harmonization of evaluation structure of LLM (Regular) programme, offered by University School of Law and Legal Studies in accordance with existing norms of Ordinance -11 of the University.	11
12	AC44.12	To consider and approve the harmonization of the Paper Code and Paper ID of Subjects being taught in LLM programme of One year duration offered by University School of Law and Legal Studies.	11
13	AC44.13	To consider and approve the Syllabus, Curriculum, Evaluation Scheme, CET Syllabus and Eligibility Criteria for, Post Basic B.Sc. Nursing Programme to be implemented from the Academic Session 2018-2019.	12
14	AC44.14	To ratify the change in Curriculum of M.Phil. Clinical Psychology programme, implemented from the Academic Session 2017-2018.	12
15	AC44.15	To ratify the minor modification of Ph.D. Course work, offered by University School of Biotechnology, implemented from the Academic Session 2017-2018.	13
16	AC44.16	To ratify the Scheme of Examination and syllabi of Ph.D. Course work, offered by University School of Basic and Applied Sciences, implemented from the Academic Session 2017-2018.	13
17	AC44.17	To ratify the Ph.D. course work, offered by University School of Environment Management, implemented from the Academic Session 2017-2018.	13
18	AC44.18	To consider and approve the recommendations with respect to the grievance of B.Tech. programme students for mandatory papers.	14
19	AC44.19	To ratify the Admission Brochure of the University for the Academic Session 2018-19, Part-A containing details of various Programmes being offered, CET form filling Procedure, CET (s) to be conducted, eligibility conditions, syllabus of CET (s), Counselling Procedures etc., Part-B containing various Appendices, Part-C Counselling Schedule Summary and Part-D Refund Policy .	14

20	AC44.20	To consider and approve the Course outline and Scheme of Examination and detailed Course content of the three year Bachelor of Arts (Honours) English Programme to be implemented from the Academic Session 2018-2019 in various affiliated institutions of the University.	14-15
21	AC44.21	To consider and approve the adoption of the University Grants Commission (Minimum Qualifications for Appointment of Teachers and other Academic Staff in the Universities and colleges and measures for the Maintenance of Standards in Higher Education)(4th Amendment),Regulations,2016 ,notified vide the University Grants Commission notification no.F1-/2016 (PS/Amendment), New Delhi, dated 11th July,2016.	15
22	AC44.22	To consider and approve the Ph.D. Course work offered at University School Information Communication & Technology from the Academic Session 2018-2019 onwards.	15
23	AC44.23	To ratify the Ph.D. Course work offered at University School Information Communication & Technology from the Academic Session 2017-2018 onwards.	15
24	AC44.24	To consider and approve number of credits for the award of B.Voc Printing Technology.	16
25	AC44.25	To consider and approve the change in subject codes of the subjects named as (a) Data Communication and Networks (6th Semester Instrumental and Control Engg) from ETEC 310 - ETIC -312 applicable for batch 2015-2016 onwards for B.Tech. in Affiliated Institutions.	16
26	AC44.26	To consider and approve the suggestions regarding issue of Diploma, Advance Diploma and B. Voc as deliberated by the committee under the chairmanship of Controller of Examinations (O).	16
27	AC44.27	To consider and approve (i) Introduction of two new electives on basic and advanced entrepreneurship as a part of the M.Tech.(Biotechnology) Scheme and curriculum 2016, to be implemented from the Academic Session 2018-2019. (ii) The minor corrections in the course codes as incorporated in the B.Tech.(Biotechnology) Curriculum (2016 scheme) in the subjects taught by the University School of Basic & Applied Sciences as per the original course codes approved by the Board of School of Studies of USBAS.(The remaining scheme and course contents shall remain the same).	17

28	AC44.28	**To consider and approve the revised Course Content, (Syllabus) of MBA (Disaster Management) Weekend Programme, offered by Centre for Disaster Management Studies, to be implemented from Academic Session 2018-2019 onwards.**	17
29	AC44.29	**To co-opt maximum 10 expert members for their special knowledge as per the provisions of Statute 11 Sub-Section (viii) of Section (1) of the Guru Gobind Singh Indraprastha University Act to be members of the Academic Council.**	18
30	AC44.30	**To consider and approve the regulations under Ordinance 12 for programmes leading to the Degree of Doctor of Philosophy (Ph.D.)**	18

Agenda Item No. AC44.15:To ratify the minor modification of Ph.D. Course work, offered by University School of Biotechnology, implemented from the Academic Session 2017-2018.

The Academic Council noted that in accordance to the revised Ph.D Ordinance12 (2017) in the University, the Ph.D course work is made at par with the overall curriculum framework of the University (lecture+ tutorials). The overall credits increased from 3 to 4. This is the minor modification as the rest of scheme and the course titles and contents for the Ph.D course work essentially remain same.

The Academic Council ratified the minor modification of Ph.D. course work, offered by University School of Biotechnology, implemented from the Academic Session 2017-2018.

The ratified minor modification of Ph.D. course work is annexed as Annexure–XII,page(XII-01 to XII-06).

Agenda Item No. AC44.16:To ratify the Scheme of Examination and Syllabi of Ph.D. Course work, offered by University School of Basic and Applied Sciences, implemented from the Academic Session 2017-2018.

The Academic Council noted that in accordance to the revised Ph.D Ordinance12 (2017) in the University, the Ph.D course work is made at par with the overall curriculum framework of the University (lecture+ tutorials). The overall credits increased from 3 to 4. This is the minor modification as the rest of scheme and the course titles and contents for the Ph.D course work essentially remain same.

The Academic Council ratified the Scheme of Examination and Syllabi of Ph.D. Course work, offered the University School of Basic and Applied Sciences, implemented from the Academic Session 2017-2018.

The ratified Scheme of Examination and Syllabi of Ph.D. Course work is annexed as Annexure –XIII ,page (XIII-01).

Agenda Item No. AC44.17: To ratify the Ph.D. course work, offered by University School of Environment Management, implemented from the Academic Session 2017-2018.

The Academic Council noted that in accordance to the revised Ph.D Ordinance12 (2017) in the University, the Ph.D course work is made at par with the overall curriculum framework of the University (lecture+ tutorials). The overall credits increased from 3 to 4. This is the minor modification as the rest of scheme and the course titles and contents for the Ph.D course work essentially remain same.

The Academic Council ratified the Ph.D. Course work offered by the University School of Environment Management, implemented from the Academic Session 2017-2018.

The ratified the Ph.D. Course work is annexed as Annexure –XIV,page (XIV-01).

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SYLLABUS

(As per New Ph.D Ordinance and w.e.f 2017 onwards)

Ph.D. Course Work

(Environmental Sciences)

w.e.f AS 2017 Onwards

Enterpreneurship | Employbility | Skill Development

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

The Ph.D Research Scholars admitted in the Ph.D programme of University School of Environment Management will be offered to take three courses (each of 04 credits) equivalent to 12 credits. The Ph.D Research Scholar will have to pass in any of the courses worth 08 credits, including a compulsory course of Research Methodology.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

UNIVERSITYT SCHOOL OF ENVIRONMENT MANAGEMENT
GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY

PhD (Environmental Science)

Programme Outcomes (POs)

PO1: Instruct and exhibit the knowledge and ability to teach university level course to the research scholar in their areas of interest/specialization.
PO2: Apply and demonstrate investigation and methodological skills to evaluate and carry out research in their area of interest and other areas.
PO3: Designing of research independently and to apply and carry out research in their area of specialization.
PO4: Demonstrate the capability to analyze the results using various statistical techniques and to communicate the result in a intelligible and effective manner.
PO5: Inculcate the understanding for high-ethical practices and standards in carrying out research in environmental sciences.

Programme Specific Outcomes (PSOs)

PSO1: The students will acquire in-depth and comprehensive knowledge about research methodology, data interpretation and statistical analysis, communication skills for writing effective research articles, and understanding ethical principles in research.
PSO2: They will develop ability to pursue contemporary and advanced research in various fields of bioresources and environment using advanced analytical instruments and other tools such as geospatial techniques.
PSO3: The students will learn basic and applied approaches of treatment and restoration of various types of polluted and environmentally degraded systems in eco-friendly manner along with resource recovery options for bioremediation research.
PSO4: The students will understand the importance of taxonomy for the conservation of biodiversity and will acquire skills to do fundamental and application-based research in various aspects of plant reproductive ecology to develop criteria and strategies for effective conservation plans.
PSO5: The students will acquire knowledge and skills on wetland ecology and functioning required to undertake research on wetland and watershed management.
PSO6: The students will understand ecosystem functions, services, climate change, environmental policies and regulation along with in-depth knowledge on various aspects of natural resource management.
PSO7: The students will acquire in-depth knowledge on various methodologies in animal field ecology, understand the challenges associated with biodiversity conservation and how to develop criteria and strategies for effective conservation plans

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LIST OF Ph.D COURSEWORK (ENVIRONMENTAL SCIENCES)

S. NO.	CODE NO	SUBJECT	L
Compulsory Paper			
1.	PES-901	RESEARCH METHODOLOGY	4
2.	PES-921	Research and Publication Ethics	2
Elective (Choose any one)			
3.	PES-903	ENVIRONMENTAL BIOTECHNOLOGY AND BIOREDMEDIATION	4
4.	PES-905	BASIC AND APPLIED REMOTE SENSING AND GIS	4
5.	PES-907	ADVANCED ANALYTICAL TECHNIQUES AND INSTRUMENTATION	4
6.	PES-909	ENERGY BALANCE AND GLOBAL CLIMATE CHANGE	4
7.	PES-911	WETLAND CONSERVATION AND MANAGEMENT	4
8.	PES-913	ECOSYTEMS AND NATURAL RESOURCES MANAGEMENT	4
9.	PES-915	SYSTEMATICS AND REPRODUCTIVE ECOLOGY OF PLANTS	4
10.	PES-917	WATERSHED MANAGEMENT	4
11.	PES-919	ANIMAL ECOLOGY AND CONSERVATION	4

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Course Code: PES 901 **L: 4 T: 0 Credits: 4**

Course Title: RESEARCH METHODOLOGY

CO1: Identify classify and compare different types of research design, identifying gap areas from literature review and demonstrate the process of research to the researchers.
CO2: Exhibit the process of research problem formulation, specific research objectives and development of working hypotheses.
CO3: Describe different types of data sources, sampling techniques and explain the process to collect qualitative and quantitative data sets.
CO4: Demonstrate the concept of technical writing and thesis writing, ethical issues and patent trade related aspects of intellectual property rights.

Unit-I

Introduction & Research Formulation: Definition and formulation of the research problem, selecting the problem, necessity of defining the problem. Importance of literature review in defining a research problem, Literature review, Primary and secondary sources-reviews, treatise, monographs-patents, web of science as a source, Critical literature review-Identifying gap areas from literature review, Research Process, scientific investigation and development of working hypothesis.
Types of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs.Qualitative, and Conceptual vs. Empirical.
Processing and Analysis of Data: Central tendency dispersion, asymmetry, normal probability distribution, skewness and kurtosis, Karl Pearson correlation coefficient, correlation, regression analysis, partial and multiple correlation and regression equation, time series analysis.

UNIT-II

Statistical inference: Concept of standard error, Normal and Poisson distribution, sampling distribution, standard error, sample size, null hypothesis and alternative hypothesis, Z-test, t-test, x2-test, F-test, testing of correlation coefficients, ANOVA, one way ANOVA, two ways ANOVA, Introduction to statistical software.

UNIT-III

Non-parametric Tests: Wilcoxon signed rank test, Kruskal-Wallis test, medium test, Mann-Whitney U test, Spearman's rank correlation.
Multivariate analysis: Multiple regressions, multiple analysis of variance, Factor analysis cluster analysis, and discriminate analysis.
Measurement uncertainty, Quality control and Quality assurance.

Unit-IV

Constructing an Instrument for data collection: Methods of data collection, collecting data using primary sources, Unstructured and structured interview, The questionnaire,

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advantages and disadvantages of questionnaire, forms of questions, collecting data using secondary sources, problems of using data from secondary sources.

Paper writing and Technical Report Generation: Basic concept of paper/thesis writing, Ethical issues, Copy right, Intellectual property rights and patent law-Trade Related aspects of Intellectual Property Rights – Reproduction of published material-Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

Texts books:

1. Black, Ken (2007), Business statistics: For contemporary decision making, Wiley, 5th Edition.
2. Ross, Sheldon M. (2016), Introductory Statistics , Academic Press, 3rd Edition,Amsterdam
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New AgeInternational. 418p.
4. Naresh K. Malhotra (2004), Marketing Research, Pearson Education Pvt. Ltd., 4th Edition.
5. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
6. Kumar, Ranjit (2005). Research Methodology: A Step by Step Guide for Beginners,2nd Edition, Pearson, New Delhi, 332p.

References:

1. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process ofInquiry, Allyn and Bacon.
2. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge UniversityPress.
4. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, PrenticeHall.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 921 **L: 2 T: 0 Credits: 2**
Paper: Research and Publication Ethics

Paper Code: CPE-RPE (NUES) **Credits: 2 (1T+1P)**

Course Outline:

This course has total 6 units focusing on basics of philosophy of science and ethics, research integrity, publication ethics. Hands-on-session sarede signed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, h-index, Impact Factor, etc.) and plagiarism tools will be introduced in this course.

Course Objectives:

- To acquaint the scholars with the concept of scientific conduct.
- To equip the scholars with the ways to avoid publication misconduct.
- To enable the scholars to explore the domain of open access publishing.
- To enable the scholars to use research databases for exploring research problem.

Pedagogy: Class room teaching, guest lectures, group discussions, and practicalsessions.

Evaluation:

- Continuous assessment will be done through tutorials, assignments, quizzes, and group discussions. Weightage will be given for active participation. Final written examination will be conducted at the end of the course.

Course structure:

- Thecoursecomprisesofsixmoduleslistedintablebelow.Eachmodulehas4-5units.

Module	Unit Title	Teaching Hours
Theory		
RPE01	Philosophy and Ethics	4
RPE02	Scientific Conduct	4
RPE03	Publication Ethics	7
Practice		
RPE04	Open Access Publishing	4

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RPE05	Publication Misconduct	4
RPE06	Databases and Research Metrics	7
	Total	**30**

Syllabus in detail

THEORY

Unit-I (RPE 01): Philosophy and Ethics (3hrs.)

- Introduction to philosophy: definition, nature and scope, concept,branches
- Ethics: definition, moral philosophy, nature of moral judgements andreactions.

Unit-II: (RPE 02): Scientific Conduct (5 hrs.)

- Ethics with respect to science andresearch
- Intellectual honesty and researchintegrity
- Scientific misconducts: Falsification, Fabrication, and Plagiarism(FFP)
- Redundant publications: duplicate and overlapping publications, salamislicing
- Selective reporting and misrepresentation ofdata

Unit -III (RPE 03): Publication Ethics (7hrs.)

- Publication ethics: definition, introduction andimportance
- Best practices / standards setting initiatives and guidelines: COPE, WAME,etc.
- Conflicts ofinterest
- Publication misconduct: definition, concept, problems that lead to unethical behavior and vice versa,types
- Violation of publication ethics, authorship and contributor ship
- Identification of publication misconduct, complaints andappeals
- Predatory publishers and journals

PRACTICE

Unit-IV (RPE 04): Open Access Publishing (4hrs.)

- Open access publications andinitiatives
- SHERPA/RoMEO online resource to check publisher copyright &self-archiving policies

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- Software tool to identify predatory publications developed bySPPU
- Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester,etc.

Unit-V: (RPE 05) Publication Misconduct (4hrs.)

A. Group Discussions (2hrs.)

- Subject specific ethical issues, FFP,authorship
- Conflicts ofinterest
- Complaints and appeals: examples and fraud from India and abroad.

B. Software tools (2hrs.)

- Use of plagiarism software like Turnitin, Urkund and other open source software tools.

Unit-VI (RPE 06): Databases and Research Metrices (7hrs.)

A. Databases (4hrs.)

- Indexingdatabases
- Citation databases: Web of Science, Scopus,etc.

B. Research Metrics (3hrs.)

- Impact Factor of journal as per Journal Citation Report, SNIP,SJR, IPP, Cite Score
- Metrics: h-index, g index, ilO index,altmetrics

Course Expected Outcomes: After course completion, the scholars will be able to

CEO1	explain plagiarism in research filed.
CEO2	prioritize research integrity in future research work.
CEO3	explore the research metrices for a research problem.
CEO4	plan group discussion on ethical issues associated with research problem.

Suggested Readings:

- Beall, J. (2012). Predatory publishers are corrupting open access. Nature, 489(7415), 179-179. https://doi.org/10.1038/489 1 79a
- Bird, A. (2006). *Philosophy of Science.* Routledge.
- Chaddah, P. (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-93-87480-86-3.

Approved in the 14th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

- Indian National Science Academy (INSA), Ethics in Science Education, Research and Govemance(2019) , ISBN:978-81-939482- l- 7. httj>://www.insaindia.res.in/pdf/Ethics Book.pdf
- MacIntyre, Alasdair (1967) *A Short History of Ethics.* London.
- National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). *On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition.* National Academies Press.
- Resnik, D. B. (2011). What is ethics in research & why is it important. *National Institute of Environmental Health Sciences,* 1-10. Retrieved from https://www.niehs.nih.gov/research/resources/bioethics/whatis /index.cfrn

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Course Code: PES 903 **L :4T: 0 Credits: 4**

Course Title: Environmental Biotechnology and Bioremediation

CO1:The course is designed to educate research scholars about environmental biotechnology and its application in various sectors.
CO2:Understanding the basic concepts of enzymes and their importance. Students will acquire skills on working with enzymes and analyzing their various properties. They will develop ability to immobilize enzymes and use them for various industrial and environmental applications
CO3:Students will gain in-depth knowledge of recent approaches of waste treatment and management along with resource recovery options in a sustainable manner.
CO4:Identification of skills to explore different bioremediation processes for the benefit of society and environment and address the associated challenges.

Unit-I

Basics of Environmental Biotechnology: Introduction, scope and importance, Applications,Genetic engineering, GMOs and Bioethical issues
Biomarkers, Biosensors of pollution: BOD sensors, Ammonia sensors, Microbial proteincharacterization, purity and molecular weight,Biofuels and bioplastics.

Unit-II

Enzyme Technology: Introduction, Basics of enzymology- Activity assay and characterization.
Enzyme immobilization: Concept, methods of immobilization, applications of immobilized enzymes in environmental research
Industrial enzymes**:** Enzyme applications in food industry, paper and pulp industry, textile industry, pharmaceutical, dairy, distillary, detergency.

Unit-III

Wastewater treatment Technologies: Aerobic and anaerobic methods for treatment of wastewaters– Role of microbes like methanogens, acetogens and fermentative bacteria; biofilms ; Constructed wetland technology
Wastemanagement: Solid waste composting;vermicomposting; energy from solid wastes
Biodegradationof Xenobiotics:Xenobiotic compounds and their microbial degradation

Unit-IV

Bioremediation Technologies: Ex-situ and in-situ Bioremediation, microbial removal of toxic metals, Phytoremediation techniques, Energy recovery through bioremediation of wastewaters, Role of biota in sequestration of carbon dioxide, Biohydro metallurgy – Role of microbes, Role of Microbes in enhanced oil recovery

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Recommended Books:

1. Alan Scragg (2005) Environmental Biotechnology, 2nd Edition, Oxford UniversityPress.
2. Bruce Rittman, Perry L. McCarty (2000) Environmental Biotechnology: Principles andApplications, 2nd Edition, McGraw-Hill.
3. I. S. Thakur (2011) Environmental Biotechnology: Basic Concepts and Applications.2ndEdn, I K International Publications.
4. B.C. Bhattacharya and Rintu Banerjee (2007). Environmental Biotechnology, OxfordUniversity Press, 2007.
5. L. Stryer (2002) Biochemistry, 5th edition, W.H. Freeman and Company.
6. N. C. Price and L. Stevens (2000) Fundamentals of Enzymology, 3rd edition, OxfordUniversity Press, USA.
7. Wolfgang Aehle (2007) Enzymes in Industry: Productions and Applications, 3rd edition Wiley-VCH.
8. M.J. Pelczar, E.C.S Chan, N.R. Krieg, 1998. Textbook of Microbiology, 5th edition TataMcGraw Hill Publishing Co. Ltd., New Delhi.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 905 **L :4 T:0**

Credits: 4Course Title: BASIC AND APPLIED REMOTE SENSING AND GIS

CO1: After completing the course research scholars will enable to understand the basic principles of Remote Sensing, GIS and GPS and their applicability.

CO2: The course will immensely help the scholars to understand the functionality and contributions of global satellite series.

CO3: This will help the scholars how to integrate spatial data with other attribute data.

CO4: Once basic is clear students will have overall idea about the utilities of this technology in different fields of environment with emphasis on natural resource management.

UNIT- I

Introduction to Remote Sensing: Remote sensing definition and physical basis, electromagnetic spectrum, radiation laws, atmospheric effects, basics of optical, thermal and microwave remote sensing, history of remote sensing. EMR interaction with earth surface materials, spectral signatures of vegetation, water, soil and snow in different regions of EMR, ground truth data collection. Aerial and spaceborne platforms, orbits, sensors types – optical (multispectral, hyperspectral), thermal and microwave. Remote sensing resolutions. Landsat, SPOT, IRS, ERS, Radarsat, RISAT, Cartosat, Resourcesatand other operational remote sensing satellites.

UNIT-II

Remote Sensing Data Analysis: Digital Image Processing (DIP) techniques: Image rectification & restoration, Image enhancement, Data merging, Image classification, Hyperspectral image analysis, Biophysical modeling and Image transmission and compression. Visual image interpretation tools and techniques.

UNIT-III

Geographical Information System and GPS : Basic, principle and components of GIS, spatialinformation and spatial data type, geographic phenomena, fields, objects, boundaries. Raster based GIS data processing with regular and irregular tessellations. Vector based GIS data processing, topology, spatial relationship and spatial analysis. Map projection, datum, spheroid, scale and coordinate systems. Survey of India topographical map types and numbering system. Satellite based navigation systems:Basic principles of Global Positioning System and its applicability.

UNIT-IV

Applications: Applications of remote sensing and GIS in ecosystem inventory and monitoring, natural resource management, agriculture, forestry, wetlands, urban planning, snow and glaciers, coastal zone management, disaster management, landslide hazard zonation, watershed management, mine closure planning. Suitability analysis of wild species. Site selections for afforestation programme, sewage treatment plants, industry and landfill sites.

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Text/References:

1. Joseph, George. 2005. Fundamentals of Remote Sensing, 2nd Edition. University Press India.
2. Lillisand, Thomas, Ralph W. Kiefer and Jonathan Chipman. 2007. Remote Sensing and Image Interpretation. Wiley India.
3. Jensen, John R. 2009. Remote Sensing of the Environment: An Earth Resource Perspective, 2nd Edition. Dorling Kindersley.
4. Lo, C.P., and Albert K.W. Yeung. 2009. Concepts and Techniques of Geographic Information Systems, 2nd Edition. PHI Learning.
5. Rolf A. de. 2001. Principle of Geographic Information System. ITC Educational Text Book Series 1. International Institute of Geoinformation Science and Earth Observation (ITC). Enschede.
6. 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.
7. Burrough, P.A. 2007. Principles of Geographic Information System. Oxford University Press.
8. Sabins, Floyd F. 2007. Remote Sensing: Principle and Interpretation. Waveland Press.
9. 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.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 907 **L- 4, T-0, Credits- 4**

Course Title: ADVANCED ANALYTICAL TECHNIQUES AND INSTRUMENTATION

CO1: Undertake the correct sample preparation and characterization prior to analysis by the chosen techniques or instruments.
CO2: Enabling selection of the most appropriate technique/instrumentation for conducting research.
CO3: Understanding the work-flow procedure and the limitations of the technique involved.
CO4: Justification of the approach taken to process the data and detailed data interpretation.

UNIT-I

Principle, Methodology and Applications: Electrophoresis, Polymerase Chain Reaction (PCR), Real time PCR, Cryopreservation, Fundamentals of Microscopy: Optical microscopy (Simple, Compound, Stereozoom, Brightfield, Confocal, Florescence), Electron microscopy (TEM &SEM).

Unit-II

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 NucleotidePolymorphism (SNP); Numerical methods in Phylogenetic Classification.

UNIT-III

Fundamentals of Colorimeters and Spectrophotometers: Electromagnetic radiation, Laws governing absorption of Radiation, Absorption instruments, Ultraviolet and Visible Absorption Spectroscopy, Colorimeters/ photometers, Spectrophotometers, Sources of Errors in Spectroscopy, External calibration of UV-Visible Spectrophotometer.
Principles of Flame photometry: Construction details of flame photometer, Types of flame photometer, Instrumentation: Fuel gases, atomiser, burner, optical system, recording system, Expression of Concentration, Interferences encountered, Procedure for determinations .
Atomic absorption spectrophotometer: Theoretical concepts, Instrumentation: Hollow cathode lamps, Burners and flames, Plasma excitation sources, optical and electronic systems, Sources of Interference: Physical, Chemical and Optical.

UNIT: IV

Chromatography: General description, Definition, Terms and parameter used in chromatography, Classification of chromatographic methods, criteria for selection of stationary and mobile phase nature of adsorbents, Rate theory, Band broadening: Eddy diffusion, Methodology for selection of stationary phase.
Liquid Chromatography: Types of Liquid Chromatography, High pressure liquid chromatography: Apparatus, Pumps, Column packing, Characteristics of liquid chromatography, Detector; UV, IR, Refractometer and Fluorescence detector.
Gas Chromatography: Principle, Comparison of GSC and GLC instrumentation, Columns: Packed and Tubular, Study of detectors: Thermal conductivity, Flame ionisation and Electron capture detector, Factors affecting separation, Methods of measurement of peak height and peak areas, Introduction and principles of GC-MS.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Text / References:

1. Murphy, D.B. and M.W. Davidson. (2012). Fundamentals of Light Microscopy andElectronic Imaging (2nd Edition). John Wiley & Sons, Inc., Publication.
2. Benson, E.E.(1999). Plant Conservation Biotechnology. Taylor and Francis, London
3. Henry, R. J. (1997). Practical Application of Plant Molecular Biology. Chapman and HallPublication, London.
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. D.A. Skoog,(2000), Principles of Instrumental analysis, fifth edition , Saunders collegepublication
7. D.H.Williams and J. Fleming(1995), Spectroscopic methods onn organic chemistry, Sixthedition , McGrawHill
8. B.K. Sharma (2007), Instrumental methods of chemical analysis, Krishna prakash media
9. J.Willard(1999), Instrumental methods of analysis, seventh edition , CBS publishers

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES909 **L: 4 T: 0 Credits: 4**

Course Title: Energy Balance and Global Climate Change

CO1: Discuss the composition of the atmosphere, global climate system and describe the past climate and paleoclimatology
CO2: Exhibit the process of climate feedbacks, direct forcing by greenhouse gases and impact of aerosols on climate change
CO3: Describe the estimation of Global Warming Potential, carbon intensity of the fossil fuels and regional and global impacts of climate change.
CO4: Demonstrate the concept of global energy balance, radiation budget of the atmosphere and apply the concepts of Gaussian plume models in transport of air pollutants.

Unit-I

Introduction to Climate System: The Global Climate System: Energy balance of the Earth, Composition of the atmosphere and changes, Past Climates and Paleoclimatology, trace gasses in the atmosphere, Global temperature, Orbital variation and sunspots, The physics of the climate science, equilibrium and realized,temperatures, climate sensitivity parameters, effect of changing albedo on climate.

Unit-II

Radiative forcing and Climate Change: Climate feedbacks (water, clouds, ice albedo). Direct forcing by green house gasses; carbon dioxide; Methane; nitrous oxide; halocarbon numbering systems; Radiative effects of aerosols, measurements technologies; impacts of aerosols on visibility and climate.

Global Warming Potential: Fundamentals of GWP, Introduction to the calculation of GWP,carbon emissions from fossil fuels and global carbon cycle, carbon intensity of fossil fuels, Effects of energy efficiency on carbon intensity, target CO2 levels.

Unit-III

IPCC Emission Scenarios: Average temperature forecasts for the glob, stabilizing the greenhouse gas concentrations, Regional and global impacts of climate change; the pecans and climate change;Changes in the stratospheric Ozone: solar spectrum and ultraviolet rays, protective shield and ozone role, effect of ozone depletion on surface UV radiation.

Climate System Modelling: Simple global temperature model, Global energy balance and radiation budget of the atmosphere,Budyko's Ice-Albedo Feedback Model

- Modelling Climate I: Climate sensitivity and feedback
- Modelling Climate II: Global and regional climate models
- Modelling Climate III: Socio-Economic Scenarios
- DeNitrification and DeComposition model

Unit-IV

Atmospheric Dispersion: Transport of air pollutants, Turbulent diffusion: real plumes and Gaussian plumes, Wind rose diagram, Atmospheric system (stability and dispersion parameters) Gaussian Plume Models and review, Plume Downwash: Stack Height USEPA Models and their applications Screening Models (SCREEN), Puff Model, Multiple Source Models (Industrial Complex Source, ISC), Modeling Chemistry of Air Pollution, Chemical Models and Photochemical Smog, Stratospheric Ozone Depletion.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Texts/References:

1. Egbert Boeker and Rienk van Grondelle (2013) Environmental science Physical Principles and Applications, John Willey & Sons, Limited, New York
2. John Houghton, (2004) Global warming : The complete briefing, Cambridge University Press, Third Edition
3. R. Lal. J. M. Kimble and B.A, (2000) Stewart Editors. Global Climate Change andTropical Ecosystems, CRC Press, London.
4. Barbara J. Finlayson-Pitts and James N. Pitts, Jr.,(1999) Chemistry of the Upper andLower Atmosphere, Academic Press.
5. John H. Seinfeld and Spyros N. Pandis, (2006) Atmospheric Chemistry and Physics:from Air Pollution to Climate Change, 2nd Edition, Wiley & Sons
6. Gilbert M. Masters and Wendell P. Ela (2014) Introduction to Environmental Engineering and Science, Third edition, PHI Learning Private Limited, Delhi

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 911 **L: 4 T: 0 Credits:**

4Course Title: WETLAND CONSERVATION AND MANAGEMENT

CO1: Upon completion of this course students will be able to reliably demonstrate understanding of how wetland ecosystem's function, analyze and interpret limnological data, and apply limnological information to wetland management.
CO2: Explain how physics, biology, geology and nutrient cycles interact in wetland ecosystem.
CO3: Students will be able to communicate effectively with the community of wetland scientists, managers and policy makers
CO4: Students will identify the skills required to understand and address wetland ecosystem management challenges.

UNIT-I

INTRODUCTION: Wetlands:definitions, origin of wetlands, types, wetland classification systems (US Fish & Wildlife, Ramsar, Indian). Properties of water, ecology of fresh water, marine, and estuarine ecosystems specifically with respect to hydrology, and biodiversity, Biological adaptations to the wetland environment (plants and animals).

UNIT -II

FRESHWATER WETLANDS: Stratification and zonation in lentic and lotic ecosystems,Nutrient cycling, Eutrophication, Trophic State Index, Green House Gas emissions, Methanogenesis, Carbon sequestration, wetlands and climate change. Wetland bioassessment and biocriteria:biological assemblages, Index of Biological Integrity (IBI), Functional assessment of wetlands.

UNIT-III

MARINE & ESTUARINE WETLANDS: Case I & II waters, stratification and zonation, estuary types and genesis; organisms (plants, animals, microbes) in various ecological zones, nutrient cycling and dynamics, upwelling and downwelling of nutrients; mangroves, coral reefs.

UNIT-IV

WETLAND MANAGEMENT: Ecosystem services of wetlands, Elements of restoration ecology:succession, assembly, landscapes; wetland metrics, wetlands and their catchments, wetland conservation in India, Ramsar sites, national parks and bird sanctuaries. Remote sensing and GIS in wetland conservation and restoration. Wetlands in disaster management. International Conventions and protocols:Ramsar Convention, Convention on Biological Diversity.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Recommended Books/References

1. M. Dobson (2000). Ecology of Aquatic Management, Pearson Education
2. Mitsch, W.J. and J.G. Gosselink (2015). Wetlands, 4th edition, John Wiley & Sons. 744p.
3. Van Der Valk, Arnold G., and Arnoud Van Der Valk (2012). The Biology of FreshwaterWetlands. Oxford University.
4. Paul A. Keddy (2010). Wetland Ecology: Principles and Conservation. CambridgeUniversity Press, 516p.
5. Walter K. Dodds (2002). Fresh Water Ecology-Concepts and Environmental Applications, Academic Press.
6. Peter Castro and Michael E. Huber (2003). Marine Biology. 4th Edition. Mc-Graw Hill.http://www.ramsar.org

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 913 **L: 4 T:0**

Credits:4Course Title: ECOSYSTEMS AND NATURAL

RESOURCES MANAGEMENT

CO1: Students will largely understand the contribution of ecosystem for societal development.
CO2: This course shall provide many opportunities to students for critical thinking on how ecology, economy and livelihoods aspects are interlinked.
CO3: Students will understand the value of natural resources and how to calculate those parameters.
CO4: Various research needsbased discussion will emerged for all ecosystems, to have fair knowledge and skill for further analysis and better management of NRs.

UNIT -I

Ecosystem management and restoration: Ecosystem management- principles, guidelines and applications; ecosystem approach for environment management; Ecosystem degradation, degraded ecosystem types and their restoration methods; Landscape elements and ecosystems-Island biogeography theory; patch, matrix and corridor model of landscapes; scale, heterogeneity, patterns; fragmentation; flows between landscape elements and ecosystems; Urban ecosystem Urbanization and its impact, Urban Heat island affect. Landscape ecology in ecosystem management ecosystems. Sustainability and society, (social justice, development, economy). UNEP programmes towards sustainable development.

UNIT- II

Aquatic and wetland resources: Surface and ground water resources – types and distribution; Elements of structure, functions and processes in fresh water (lakes and rivers), marine and estuarine ecosystems with respect to hydrology, and biodiversity; stratification and zonation in rivers, lakes and oceans. Biological adaptations in plant and animals. Bioassessment and biocriteria in lakes and reservoirs; eutrophication and trophic state index; methanogenesis; Ramsar Convention, Convention on Biological Diversity, Ramsar sites in India.Freshwater and Marine resources: Fish, weeds and other products; biodiversity as a resource and environmental issues.

UNIT-III

Watershed management: Watershed definition, types, Watershed Characteristics, land capability classification, erosion, Universal Soil Loss Equation (USLE); hydrology of watersheds. Watershed inventory, watershed restoration and prioritizationcatchment area conservation, integrated watershed management plan, monitoring and evaluation of watershed management activities, climate change adaptation, economics of watershed protection, ecosystem services, research issues in watershed, Indian case studies of watershed development

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UNIT-IV

Natural Resources: Concept of natural resources as natural capital. Types of natural resources, interrelationships among different types of natural resources. Common Property Resources. Biodiversity as a resource, Ecosystem services; Ecological, social and economic dimension of resource management. Forest resources- status, types and distribution.Timber and Non- timber forest resources. Sustainable Forest Management. Wild Food resources. Mineral resources and their exploitation; Livelihoods and natural resource. Ecological impacts of resource exploitation on society and environment. Policy implications of natural resource management. Linkages of NRs with UN Sustainable Development Goals. Emergingresearch issues in natural resource management.

Text/References:

1. E.P.Odum and Gray W.Barrett (2005) Fundamentals of Ecology (5th Editing) CengageLearning.
2. Francois Ramade (1984). Ecology of Natural Resources. John Wiley & Sons Ltd.
3. M. Dobson (2000). Ecology of Aquatic Management, Pearson Education
4. Mitsch, W.J. and J.G. Gosselink (2015). Wetlands, 4th edition, John Wiley & Sons. 744p.
5. Raymundo E. Russo (2008). Wetlands: Ecology, Conservation and Restoration. Nova Science Publishers Inc. 446p.
6. Frederick R. Adler and Colby J.Tanner (2015) J.Tanner (2013) Urban Ecosystem:Ecological Principles for the Built Environment, Cambrdige University Press.
7. Prodyut Bhattacharya (2018) Redefining Forestry for Effective Livelihoods. NewDelhi : TERI
8. Prodyut Bhattacharya andA.K.Kandya(2017)Sustainable Forestry : Emerging Challanges. IK International Publishing House Pvt. Ltd., New Delhi.
9. West, P.W. Trees and Forest Management. 2004, Springer Publication
10. Montagnini, Florencia, Jordan, Carl F. 2007 Tropical Forest Ecology: The Basis forConservation and Management. Springer Publication
11. James P. Kimmins 2006 Forest Ecology, Pearson Publication.
12. Larr, Anthonie Van, Akca Alparslan 2007 Forest Mensuration, Springer Publication
13. Jelte van Andel and James Aronson (editors) (2006). Restoration ecology : the new frontier, Blackwell Publishing, 319p
14. Martin R. Perrow, Econ and Anthony J. Davy [Ed] (2002), Handbook of EcologicalRestoration, Volume 1 and 2, Cambridge University Press.
15. Sven Erik Jorgensen [Ed] (2009). Applications in Environmental Engineering, Elsevier B.V. Radarweg, Amsterdam, The Netherlands, 380p.
16. Ecological Restoration (2008). A Source Book for Ecological Restoration, Foundationfor Ecological Security, 104p.
17. Watershed Planning and Management (2000)- Rajvir Singh, Yash Publication House,Bikaner-India
18. YVN Murthy. Land and Water Management, Kalyani Publishers, New Delhi.
19. I.W. Heathcote (1988). Integrated Watershed Management: Principles and Practice, John Wiley and Sons, Inc., New York.

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 915 **L: 4 T: 0**

Credits:4Course Title: SYSTEMATICS AND REPRODUCTIVE ECOLOGY OF PLANTS

CO1: Strengthen the fundamentals of nomenclatural rules and knowledge of different Codes used in Plant Nomenclature.
CO2: Acquire skills to do fundamental and applicative research using various parameters of morphology and molecular tools in plant studies including phytogeography required to become a skilled taxonomist and reproductive ecologist.
CO3: Learn to understand the intricacies of plant reproductive ecology, their applications in addressing and depicting the impacts of climate change on range shift and phenology.
CO4: Prepare the students to become an entrepreneur in the fields of apiary, pollination consultants, seed collector & biologists, Plant Nursery using micropropagation techniques and consultant as Biodiversity Conservationist.

Unit -I

Major systems of classification: basis, merits and demerits: Bentham and Hooker, Cronquist; Takhtajan'sSystem, basis of APG Classification, brief idea about APG IV (2016). Concepts of palaeoherbsand eudicots (tricolpates). Cladistics: A brief account: definition and application. International Code of [Botanical] nomenclature [ICN/ICBN]; Proposed BioCode and PhyloCode

Unit-II

Data Sources and Tools of Taxonomy: Embryology, Palynology, Anatomy, Molecular taxonomy–DNA barcoding. Species, Biosystematics and Numerical Taxonomy: Species concept. Biosystematics: Objectives, steps, categories, relationship with classical taxonomy. Numerical Taxonomy (Phenetic methods): Definition, Principles, methods, merits and demerits.
Phytogeogarphy : Principles of phytogeography; endemism; hotspots; phytogeogarphical divisions of India: vegetation of Delhi.Botanical Gardens and Botanical survey of India. General idea about Red Data Book

Unit-III

Introduction to plant reproductive systems:Reproductive mechanisms in flowering plants. Phenology. Floral Structure and function. Male reproductive system: Mature pollen grain, structure and function; pollen viability. Female reproductive system: Pistil development, structure and function; stigma receptivity, style and ovary; types and viability of ovule.

Unit-IV

Pollination Systems and Ecology. Breeding Systems. Fruit and Seed Biology. Seed Dispersal. Seedling Recruitment. Reproductive Ecology and Conservation

Plant Systematics

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

TEXT BOOKS

1. Bennet, S.S.R. (1989). An Introduction to Plant Nomenclature. International Book Distribution, India.
2. Heslop J. Herrison, (1970). New Concepts in Flowering Plants - Taxonomy. Heinemann Educational Books, India, Revised Edition.
3. Heywood VH. (1967). Plant Taxonomy, Edward Arnold, London.
4. Jeffery C. (1982). An introduction to Plant Taxonomy, J& A Churchill Ltd., London
5. Lawrence, GHM. (1995). The Taxonomy of Vascular Plants (Vol I IV) ,Central Book,Dept., Allahabad
6. Maheshwari J. K (1963). Flora of Delhi .CSIR, New Delhi.
7. Pandey, B.P. (1997).Taxonomy of Angiosperms, S.Chand& Co., New Delhi.
8. Pandey, S.N. and Misra, SP. (2008). Taxonomy of Angiosperms, Ane Books India, NewDelhi.
9. Rendle A.R. (1979). A Classification of Flowering Plants. Vol. I and II., CambridgeUniversity Press.
10. Sambamurty AVSS. (2005). Taxonomy of Angiosperms, I.K. International Pvt. Ltd.,New Delhi.
11. Saxena NB. and Shamindra Saxena (2001). Plant Taxonomy, K.K. Mittal for PragatiPrakasham, Meerut.
12. Sharma OP. (2009). Plant Taxonomy-Tata McGraw-Hill Education Private Limited,New Delhi.
13. Singh G. (2008). Plant Systematics .Theory and Practice.Oxford and IBH PublishingCo.Pvt Ltd.

REFERENCE BOOKS

1. Davis, P.H and Heywood, V.M. (1965). Principles of Angiosperm Taxonomy, Oliverand Boyd Edinburgh.
2. Hutchinson, J. (1973). The Families of Flowering plants, Oxford University press,London
3. Kress J.W, Wurdack, K.J., E.A C., Zimmer, L.A .Weigt and Janzen D.H. (2005). Use of DNA bar codes to identify flowering plants. Proc. Natl. Acad. Sci. USA 102,8369- 8374.
4. Radford A E (1986) Fundamentals of plant systematics. Harper International Edition, New York
5. Simpson M.G.(2006). Plant systematics, Elsevier Academic Press, USA
6. Stoeckle , M.(2003).Taxonomy ,DNA and the barcode of life .Bioscience 53: 796 797.
7. Takhtajan, A.L. (1969). Flowering Plants – Origin and dispersal – Oliver & Boyd
8. Takhytajan A.L. (1991). Evolutionary trends in flowering plants, Bishen SinghMahendra Pal Singh, Dehra Dun.

Reproductive Ecology

REFERENCE BOOKS

1. Dafni A (1992) Pollination ecology: a practical approach.IRL Press, Oxford/New York
2. Dafni A, Kevan PG, Husband BC (2005) Practical pollination biology. Enviroquest,Cambridge

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3. Dennis AJ, Schupp EW, Green RJ, Wescott DA (eds) (2007) Seed dispersal: theoryand its application in a changing world. CABI International, Wallingford
4. Erdtman G (1969) Handbook of palynology. Hafner,New York
5. Faegri K, van der Pijl L (1979) The principles of pollination ecology, 3rd edn. Pergamon Press, Oxford
6. Fenner M, Thompson K (2005) The ecology of seeds.Cambridge University Press,Cambridge
7. Raghavan V (1997) Molecular embryology of fl owering plants. Cambridge UniversityPress, New York
8. Richards AJ (1986) Plant breeding systems. Allen and Unwin, London
9. Schaefer HM, Ruxton GD (2011) Plant-animal communication. Oxford UniversityPress, New York
10. Shivanna KR, Rangaswamy NS (1992) Pollen biology: a laboratory manual. Springer,Berlin/Heidelberg
11. Turner IM (2001) The ecology of seeds in tropical rainforests. Cambridge UniversityPress, Cambridge
12. Willmer P (2011) Pollination and floral ecology. Princeton University Press, Princeton

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Course Code: PES 917 L: 4 T :0

Credits: 4Course Title: WATERSHED MANAGEMENT

CO1: Researchers will be able to learn about the importance of Govt guidelines and policies about the watershed management.
CO2: Researchers will be able to acquire the knowledge about the role of various watershed characteristics and their importance in watershed conservation.
CO3: Researchers will be able to learn about the different methods of rainfall, streamflow measurements and sediment load estimation.
CO4: Researchers will be able to get the knowledge about monitoring of watershed activities, economic return, impact of climate change and scope of research in watershed.

Unit -I

Watershed Definition and Scope: Concept of watershed and objectives of watershed management, mapping of watershed, delineation of watershed, types of watershed, identification of watershed problems, characteristics of watershed, objectives of watershed management and development

Unit-II

Watershed Hydrology: Concept of hydrology, hydrological cycle; analysis of precipitation data, erosion, infiltration, evapotranspiration, run-off, measurement of stream flow, concept of hydrograph, method of base flow separation, rainfall- runoff relationship, sediment load- types and methods of measurement

Unit -III

Watershed Characterization: Soil survey and its type, codification of soil survey; land capability classification: land capability ratings, drainage, geology, climate and landuse, slope and aspect, drainage morphometry, erosivity index, Universal Soil Loss Equation (USLE), soil and water conservation measures

Unit- IV

Watershed Management: Watershed inventory, watershed policies, resource use pattern, peoples participation, role of horticulture, forestry and agro-forestry in watershed management,watershed work plan, catchment area conservation, integrated watershed management plan, Indian case studies of watershed development; economics of watershed management, climate change issues in watershed, monitoring and evaluation of watershed management activities, research issues and scope in watershed.

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Text/References

1. Watershed Planning and Management (2000)- Rajvir Singh, Yash Publication House,Bikaner-India
2. Land and Water Management (1995): VVN Murthy- Kalyani Publishers, New Delhi.
3. Integrated Watershed Management in the Global Ecosystem (2000)- Rutta Lal, CRCPress, New York
4. Integrated Watershed Management: Principles and Practice (1988)- Heathcote, I. W. John Wiley and Sons, Inc., New York.
5. Hydrology: Principles, Analysis and Design (2007) - H. M. Ragunath, 3rd edition, NewAge International, New Delhi.
6. Land and Water Management (2009)- VVN Murty and MK Jha, 5th edition, KalyaniPublishers, New Delhi.
7. Hydrology, Soil Conservation and Watershed Management- Ghanshyam Das, PHI,New Delhi
8. Soil and water Conservation Engg (2009)- R. Suresh, 2nd revised edition, Standard Publishers Distributiors,1705B, Nai Sarak, Delhi

Approved in the 44th Academic Council meeting held on 3rd May, 2018 w.e.f. AS 2017-18 vide Agenda item 44.17.

Course Code: PES 919 - L: 4 T :0 Credits:

4Course Title: Animal Ecology and Conservation

CO1: To prepare trained field biologists who can contribute towards conservation.
CO2: Decision making in preparation of conservation measures for conservation dependent species.
CO3: Make update towards modern tools and techniques used in animal ecology.
CO4: Orient conservation professionals towards a strong scientific base integrating field biodata.

Unit-I

Basics of Animal Field Ecology: Introduction to habitat ecology: microhabitat to biosphere, range, area of occupancy; Material basis of animal field ecology; Niche and Resource Partitioning, Food and foraging tactics, Community and guild concept, Biotic interactions, Animal biogeography

Unit-II

Methodological Approaches in Animal Field Ecology: Field techniques for animal population assessment: Diversity indices, standard methodologies for invertebrates and vertebrates-grid count; line/belt transect, quadrat, time-constraints, point count, ad-libitum sampling, scan sampling, focal sampling, camera trapping, radio collaring, tagging, mark-capture recapture; In-direct sighting (tracks and signs).

Unit-III

Integrating Animal Field Ecology and Conservation: Ethical issues in handling wild animals, understanding issues in captive breeding programmes, species revival and species invasion, Threat value assessment, Criteria for proposing effective conservation action plan, Ecosystem approach for conservation, habit suitability modelling.

Unit-IV

Current Issues in Wildlife Conservation with Case Studies: Conflict management, Human-Wildlife Conflict (Tiger, Elephant and Crocodile),Approaches to trace poaching and illegal trading at local, national and international levels, Community based conservation approach, Impact of Climate change on species survival. .

Text/ References:

1. Bibby, C., Jones, M. and S. Marsden. (1998). Expedition Field Techniques: BirdSurveys, Royal Geographical Society, London, UK.
2. Bookhout, T. A. (1996). Research and management techniques for wildlife and habitats (5th Ed.). The Wildlife Society, Allen Press, Kansas, USA.

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3. Buckland, S. T., Anderson, D. R., Burnham, K. P. and J.L. Laake. (1993). Distance sampling-estimating abundance of biological populations. Chapman & Hall, London, reprinted (1999) by Research Unit for Wildlife Population Assessment, St. Andrews.
4. Woodroffe R., Thirgood S. and A. Rabinowitz (2005). People and Wildlife, Conflict orCo-existence? (Conservation Biology) Cambridge University.
5. Sutherland, W. J. (2000). The conservation handbook; research, management and policy. Blackwell Sciences Ltd. London.
6. Sutherland, W. J., Newton, I. and R.E. Green. (2004). Bird Ecology and Conservation:A Handbook of Techniques. Blackwell Sciences Ltd. London.
7. Groom, M.J., Meffe, G.R. and C.R. Carroll. 2006. Principles of Conservation Biology. Sinauer Associates, Inc., USA.
8. Primack, R. (2006). Essentials of Conservation Biology. Sinauer Associates, Inc., USA.
9. Krebs, C.J. (1999). Ecological Methodology. Addison-Welsey Educational Publishers,Inc., USA.

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