Five Year IntegratedMaster of Science

(Environmental Science)

Programme

Scheme and Syllabus (OBE based)

forAdvanced level courses in Semester VII to X

Institute For Integrated Programmes & Research In Basic Sciences (IIRBS)

Mahatma Gandhi University

P. D. Hills P.O., Kottayam-686560

PREAMBLE

I am happy to present the detailed curricula and syllabi of the final four semesters (7-10) of the five year Integrated M.Sc. programmes of Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)in the following five branches of Science.

1. Chemistry (CH)
2. Physics (PH)
3. Life Sciences (LS)
4. Computer Science(CS)
5. Environmental Science(ES)

It may be noted that, an expert committee wasconstituted*(vide UO 4460/ACA5/2019/MGU, dated 23.09.2019)*for framing the scheme, curriculum and syllabi for the five year Integrated Master of Science (Integrated M.Sc) programmes of Mahatma Gandhi University. Subsequently, the committee drafted the regulations, scheme, curriculum and syllabi of the five year integrated Master of science programmes of IIRBS and were approved *vide UO No. 4467/AC A 5/2020/MGU, dated 05.10.2020*w.e.f 2020 admission batch. However, this approval was involved the detailed scheme and syllabus for foundation level (first six semesters) courses and only scheme for the advanced level courses (in semesters 7-10). Now the expert committee has finalized the **detailed syllabi for advanced level courses in semesters 7-10** in accordance with the OBE format approved by the Mahatma Gandhi University and is presented hereafter. ***This syllabus shall be applicable w.e.f the 2023-24 academic year (for 2020 admisn batch) onwards.***

The expert committee has framed the curriculum as per the Outcome Based Education (OBE) system. OBE is an educational approach that bases each part of the educational system with respect to the goals set for the students. OBE aims to equip the students (learners) with knowledge, competency orientations required for achieving their goals when they depart the institution. Further OBE empowers students to choose what they would like to study and how they would like to study it. The teaching methodologies and the evaluation system are also modified in par with the outcome based approach. The programme Specific Outcomes (PSOs) and the Course Outcomes (COs) are presented in the syllabus. The PSOs and the COs are well correlated in the syllabus of each course.

-Sd-

P.D. Hills
July, 2023

Dr. S. Anas
(Convener, Expert committee)

Members of the Expert committee

1.	Dr. S. Anas, Honorary Director, IIRBS	Convener
2.	Dr. P. R. Biju, Professor, SPAP	Member
3.	Dr. K. B. Subila, Assistant Professor, SCS	Member
4.	Dr. Mahesh Mohan, Assistant Professor, SES	Member
5.	Dr. E.K. Radhakrishnan, Associate Professor, SBS	Member
6.	Dr. V. R. Bindu, Professor and Director, SoCS	Member
7.	Dr. Cyriac Joseph, Director, SPAP	Member
8.	Dr. Anitha C. Kumar, Director, SCS	Member
9.	Dr. K. R. Baiju, Director, SES	Member
10.	Dr. M. S. Jisha, Director, SoBS	Member

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS)

Institute for Integrated Programmes and Research in Basic Sciences (IIRBS**)**, was instituted directly under Mahatma Gandhi University in 2008 and was the first of this kind among the universities in Kerala. Subsequently, the Institute launched Five year Integrated Interdisciplinary Master of Science (Chemistry) programme in the year 2009. Over the years the institute has earned recognition as one of the best interdisciplinary institutions in terms of providing top-notch teaching learning environment and cutting edge instrumentation facilities. In 2020, IIRBS started innovative Five Year integrated interdisciplinary Master of Science programmes in five major disciplines of science (Physics, Chemistry,Life Sciences, Computer Science and Environmental Science). The major objective of the programmes is to integrate the conventional bachelors and masters programmes under a specified research oriented leaning environment by bringing together various science disciplines and thereby empower basic science education. These programmes are designed with an interdisciplinary approach to provide strong foundations for students to prepare for high quality research and expected to contribute to the talent pool of researchers and specialized technicians.

The regulations, scheme, curriculum and syllabi of the five year integrated Master of science programmes of IIRBS were approved *vide UO No. 4467/AC A 5/2020/MGU, dated 05.10.2020.* However, this approval was involved the detailed scheme and syllabus for foundation level (first six semesters) courses and only scheme for the advanced level courses (in semesters 7-10). Now the **detailed syllabi for advanced level courses in semesters 7-10**are prepared in accordance with the OBE format approved by the Mahatma Gandhi University.

Outcome based Education (OBE)

A high priority task in the context of education in India is improvement of quality of higher education for equipping young people with skills relevant for global and national standards and enhancing the opportunities for social mobility. Mahatma Gandhi University has initiated an Outcome Based Education (OBE) for enhancing employability of graduates through curriculum reforms based on a learning outcomes-based curriculum framework, upgrading academic resources and learning environment. Learning outcomes specify what graduates completing a particular programme of study are expected to know, understand and be able to do at the end of their programme of study. The fundamental premise underlying the learning outcomes-based approach to curriculum development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes, expressed in terms of knowledge, understanding, skills, attitudes and values. Outcomes provide the basis for an effective interaction among the various stakeholders.It is the results-oriented thinking and is the opposite of input-based education where the emphasis is on the educational process.

The OBE Framework is a paradigm shift from traditional education system into OBE system where there is greater focus on programme and course outcomes. It guarantees that curriculum, teaching and learning strategies and assessment tools are continuously enhancedthrough a continuous improvement process. All decisions including those related to curriculum,delivery of instruction and assessment are based on the best way to achieve the predeterminedoutcomes. Traditionally, educators have measured learning in terms of standardized tests. In contrast, outcome-based education defines learning as what studentscan demonstrate that they know.

OBE is a comprehensive approach to organise and operate a curriculum that is focused onand defined by the successful demonstrations of learning sought from each learner. The term clearly means focusing and organising everything in an education system around “what is essential for all learners to be able to do successfully at the end of their learning

experiences". OBE is an approach to education in which decisions about the curriculum and instruction are driven by the exit learning outcomes that the students should display at the end of a programme or a course. By the end of educational experience, each student should have achieved the outcomes

Vision and Mission of Mahatma Gandhi University

Vision

"Mahatma Gandhi University envisions to excel in the field of higher education and cater to the scholastic and developmental needs of the individual, through continuous creation of critical knowledge base for the society's sustained and inclusive growth."

Mission

- To conduct and support undergraduate, postgraduate and research-level programmes of quality in different disciplines
- To foster teaching, research and extension activities for the creation of new knowledge for the development of society
- To help in the creation and development of manpower that would provide intellectual leadership to the community
- To provide skilled manpower to the professional, industrial and service sectors in the country so as to meet global demands
- To help promote the cultural heritage of the nation and preserve the environmental sustainability and quality of life
- To cater to the holistic development of the region through academic leadership

Vision and Mission of IIRBS

Our Vision:

Quality education in basic sciences by providing intellectual, instrumental as well as experimental support for pursuing excellence and thereby contribute to the talent pool of scholars.

Our Mission:

- To promote and disseminate high level knowledge in frontier areas of science
- To develop students as multidimensional personalities to create innovators for the service of human welfare
- To equip students to build up a scientific career and contribute towards the national development
- To inculcate among students human values with global competence

Programme Outcomes (PO) of Mahatma Gandhi University

PO 1: Critical Thinking and Analytical Reasoning

Capability to analyse, evaluate and interpret evidence, arguments, claims, beliefs on the basis of empirical evidence; reflect relevant implications to the reality; formulate logical arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; able to envisage the reflective thought to the implication on the society.

PO 2: Scientific Reasoning and Problem Solving

Ability to analyse, discuss, interpret and draw conclusions from quantitative/qualitative data and experimental evidences; and critically evaluate ideas, evidence and experiences from an unprejudiced and reasoned perspective; capacity to extrapolate from what one

has learned and apply their competencies to solve problems and contextualise into research and apply one's learning to real life situations.

PO 3: Multidisciplinary/Interdisciplinary/Transdisciplinary Approach
Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills
Ability to reflect and express thoughts and ideas effectively in verbal and nonverbal way; Communicate with others using appropriate channel; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner and articulate in a specific context of communication.

PO 5: Leadership Skills
Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating a goal, building a team who can help achieve the goal, motivating and inspiring team members to engage with that goal, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility
Ability to contemplate of the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability
Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity, managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning
Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work and living as a dignified person in the society.

PO 9: Networking and Collaboration
Acquire skills to be able to collaborate and network with scholars in an educational institution, professional organisations, research organisations and individuals in India and abroad.

PO 10: Lifelong Learning
Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of workplace through knowledge/skill development/reskilling.

Programme Specific Outcomes (PSO) for

IntegratedM.Sc. (Environmental Science)

Upon completion of the Integrated M.Sc. Environmental Scienceprogramme, the students should be able to accomplish the following outcomes

PSO	Expected Outcomes
1	Understand the concepts of the environment and its interactions with the earth and environmental systems and various ecosystems associated with it.
2	Capability to analyse, evaluate and interpret the causes and effects of various environmental problems at local, regional and global scales and to develop management strategies.
3	Acquire interdisciplinary knowledge of the global aspects of climate change, its effects on the environment and its governance
4	Ability to use suitable techniques and tools for efficient management and conservation of various environmental resources, pollution control/waste treatment/management methods, remote sensing/GIS applications, and natural disaster management.
5	Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.
6	Master the core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
7	Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
8	Promote Research interest and aptitude in students and thereby enable them towards planning and execution of research in frontier areas of Environmental sciences.

SEMESTER VII to X (List of Courses Under Environmental Science Major)					
SEMESTER VII					
Code	**Course**	**L**	**T**	**P**	**C**
IMSC701ES	Ecology and Environment	2	2	0	3
IMSC702ES	Environmental Geosciences	3	2	0	4
IMSC703ES	Environmental Chemistry and Pollution	2	2	0	3
IMSC707ES	Research Methodology	2	2	0	3
IMSC704ES	Conservation Biology	2	2	0	3
IMSC705ES	Lab course-I (Environmental Pollution and Geology)	0	0	6	3
IMSE706ES	Field Study	0	1	2	2
	Total	**11**	**11**	**8**	**20**
SEMESTER VIII					
IMSC801ES	Analytical Techniques and Instrumentation	3	2	0	4
IMSC802ES	Environmental Biotechnology and Waste Management	2	2	0	3
IMSC803ES	Environmental Economics and Sustainable Development	2	2	0	3
IMSC804ES	Environmental Microbiology	2	2	0	3
IMSC805ES	Lab course-II (Ecology, Environmental microbiology, RS & GIS)	0	0	6	3
IMSE806ES-n (n=1,2,3...)	1. Ecotoxicology 2. Water resources management 3. Sanitation and Health	2	1	0	2
	Total	**11**	**9**	**6**	**20**
SEMESTER IX					
IMSC901ES	Resource Management	3	2	0	4
IMSC902ES	Environmental Engineering	2	2	0	3
IMSC903ES	Environment Management	2	2	0	3
IMSC904ES	Advanced Geomatics and Applications	2	2	0	3
IMSC905ES	Environment Impact Assessment	2	1	0	2
IMSC906OC-n(n=1,2,3...)	Open Course	4	0	0	4
IMSE907ES	Seminar- Current issues & trends in Environmental Science	0	2	0	1
	Total	**11**	**11**	**0**	**20**
SEMESTER X					
IMSC100PR	Major Research Project	0	0	0	16
IMSC100VV	Comprehensive Viva-voce	0	0	0	4
	Total	**0**	**0**	**0**	**20**

School Name	**Institute for Integrated programmes and Research in Basic Science**		
Programme	**Five Year Integrated M.Sc.(Environmental Science)**		
Course Name	**Ecology and Environment**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC701ES**		
Name of Faculty			
Course Summary& Justification	This course provides the essential basis for nature conservation by focusing on ecology and the environment. Through lectures, selected examples and case studies, the paper provides an excellent background for students who wish to understand basic concepts of ecology, environment components, the importance of biotic, abiotic factors and their interactions, ecological stability and the impact of human threats on species and ecosystems. Besides this, the programme provides insight into important contemporary environmental issues such as human ecology and human-wildlife conflict.		
Semester	**VII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include Group discussions, Problem solving sessions, Seminars, independent learning etc..	36	36		8	80

Pre-requisite	The students havean interest and general understanding of environmental science subject.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the scope and importance of ecology and environmental science	R, U	1
2	Understand and distinguish the different components of the environment, various environmental factors and various kinds of interaction occurring in nature.	U,An	1,2,3
3	Establish the concept of ecology at the levels of the organism, the population, the community and the ecosystem	U	1
4	Explain the concept of ecological stability and classify various factors contributing to ecological stability	An	1,2
5	Discuss Human-induced threats to Ecological structure and functions	E	1,2,5
6	Build central ideas behind human Ecology, including knowledge of the history, Conservation Movements, People and Nature, Indigenous communities and Ethnobiology	E	5-8
7	Define, Discuss and evaluate Ecosystem services and debate Human-wildlife Conflict	A	4-8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Ecology-An introduction** Fundamentals of Ecology- Definition, Scope and Importance of Ecology; Branches of Ecology; Interrelationship of Ecology with other disciplines.	12	1
2	**Components of the Environment** The atmosphere or the air: Layers of Atmosphere, Composition of air; importance of atmosphere, meteorological conditions and air circulation. The hydrosphere or water: Importance of water, distribution of water at global, national and state level. Hydrological cycle. Lithosphere or the rock and the soil: Elementary composition of rocks in the earth crust. Types of rocks; Process of soil formation: Physical weathering, Chemical and biological weathering of rocks; Role of soil in shaping the biosphere.	20	1,2
3	**Environmental Factors** Climatic Factors - Light, Temperature of Air (atmospheric temperature), Rainfall (precipitation),Humidity of air, atmosphere(gases and wind),fire; Topographic Factors: height of mountains, direction of mountains and valleys, steepness of slope and exposure of slope; Edaphic factors: Soil-soil formation, soil profile, soil erosion, soil conservation; Biotic factors: Intraspecific interactions; Interspecific interactions: Neutralism, Commensalism, Mutualism, Proto co-operation, Parasitism, Predation.	20	1, 2
4	**Ecological stability** Ecological organization-Species, Population, Community, Ecosystem, Biomes, Biosphere, Factors of ecological stability, Human-induced threats to Ecological structure and functions.	12	3,4,5
5	**Human Ecology** Environmental History and Conservation Movements, People and Nature: Ecosystem services, Indigenous communities and Ethnobiology, Human-wildlife Conflict.	16	6,7

References

1. *Odum, E. P. (1971), Fundamentals of Ecology, W B Saunders Company, Philadelphia.*
2. *Odum, E. P. and Barrett, G. W. (2005), Fundamentals of Ecology, Belmont, CA: Thomson Brooks/Cole, USA*
3. *Krebs, C. J. (1989), Ecological Methodology, Harper Collins Pub. New York.*
4. *Robert, L. S. (1990), Ecology and Field Biology, Harper Collins Pub, New York.*
5. *Michael, P. (1990). Ecological Methods for Laboratory and Field Investigations, Tata McGraw Hill Publishing Company Limited, New Delhi.*
6. *Chapman, J. L. and Reiss, M. J. (1992), Ecology-Principles and Applications, Cambridge University Press, New York.*
7. *Brewer, R. (1994). The Science of Ecology, Saunders College Publishing, New York.*
8. *Mukherjee, B. (1996), Environmental Biology, Tata McGraw- Hill Pub. Co. Ltd, New Delhi.*
9. *Colin, R., Townsend, Michael, B. and John, L. H. (2012), Essentials of Ecology, third Edn, Blackwell Science Publishers, New Jersey, USA.*
10. *Singh, J.S., Singh, S.P. and Gupta, S.R. (2008), Ecology, Environment & Resource Conservation, Anamaya Publications, New Delhi*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

SchoolName	**Institute for Integrated programmes and Research in Basic Sciences**					
Programme	**FiveYear Integrated M.Sc.(Environmental Science)**					
CourseName	**Environmental Geosciences**					
Typeof course	**Core**		**CreditValue**		**4**	
Coursecode	**IMSC702ES**					
NameofFa culty						
CourseSummary& Justification	The course describes therelation between the earth systems and geological agents to the environment. It explains various geological processes involved in the formation of environment and the impacts due to the exploration of geological resources.					
Semester	**VII**					
Total StudentLearningTime(SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions,Seminars,In dependent Learningetc..	54	36	-	10	100
Pre-requisite	Basic knowledge about Earth					

COURSE OUTCOMES(CO)

CONo.	Expected Course Outcome	Learning domain	PSO No
1	Explain the basics of Earth systems its processes and land forms	U	1
2	Distinguish various Platetectonic processes and resultant features	An	1,2
3	Identify major minerals, rocks and structures on the Earth	An	1,4
4	Distinguish the major landforms formed by the action of various geological agents	An,E	1,4
5	Analyse the interrelationship between various spheres (Atmosphere,Lithosphere and Hydrosphere) of theEarth	E	2,6
6	Describe the various resources of the earth and its environmental impacts due to its exploration	U,E	5
7	Appraise the different geo-scientific approaches for sustainable environment	E,I	3,7

**Remember(R), Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill(S),Interest (I)and Appreciation(Ap)*

COURSECONTENT

Module	Course Description	Hrs.	CONo.
1	**The Earth as a System** Earth in relation to Universe- Origin of the solar system-Geologic Timesscale – The Geologic Record – Evolution of life; Earth as a System ofInteracting Components–Lithosphere, atmosphere, Hydrosphere; PlateTectonics:Interior of theEarth- – Typesof PlateBoundaries-Plate mosaic–Rates of platemotion–Plate reconstruction–Mantle convection.Geological processes related to Platetectonics-Seafloor spreading,Mountain building, Earthquakes, Volcanism	16	1,2,5
2	**Materials of theearth** IntroductiontoRock-forming minerals and their Physical properties; Types of Rocks:igneous,metamorphic and sedimentary Major Rock types - Origin and composition– The rock cycle; Geological Structures: folds, faults and joints; Disintegration of rocks:Weathering:Types of weathering,Formation of Soil, Soil profile	13	1, 3
3	**Introduction to Physical Geology and Geomorphology** Geological agents and Landforms: Streams- Geological work of streams and landforms; Glaciers-types and landforms,Wind:Geological work of wind and landforms;Oceans:Shoreline process–wave erosion, deposition or accretion; modification of shorelines; Geomorphology of India and Kerala:Brief description of different important units	16	4
4	**The Hydrosphere** Hydrological cycle-Aquifers–types and properties,watertable and Groundwater movement Ground water recharge-recharge areas discharge areas;Methods of ground water abstraction-undesirable sideeffects of over exploitation-threats to groundwater system physical destruction of aquifers-groundwater depletion-degradation of ground water quality-point source of contamination-diffuse source of contamination-aquifer vulnerability-aquifer over exploitation;Sustainable groundwater development and management	17	1,5,6,7
5	**TheAtmosphere** Structure and composition of the atmosphere;Interaction between lithosphere and atmosphere:Winds,Precipitation etc.Wind–types and formation, Precipitation–rainfall,snowfall; Humidity and radiation Monsoon,El Nino, Droughts, Tropical Cyclones	13	5
6	**Geological Resources and theEnvironment** Major geological resources- minerals, rocks, coal, oil and natural gas;Environmental impacts of rocks/mineral mining and processing,Rivers and mining and its environmental concern Rock Quarrying, Clay mining andits impacts;Shoreline activities and its environmental impacts; Geological Issues in the disposal of domestic wasteand industrial waste	15	1,6,7

References

1. *DuffandHolmes2016(thirdedition),HolmesPrinciplesofPhysicalGeology,Cheltenham,England; NelsonThornes*
2. *Earle, S. (2015). Physical Geology. Victoria, B.C.: BCcampus. Retrieved fromhttps://opentextbc.ca/geology/ 719 p*
3. *FetterCW1990 AppliedHydrogeology CBSNewDelhi 592p*
4. *Grotzingeretal2007Understanding Earth,WHFreemanNewYork,579p*
5. *Mukerjee,P.K.2013 ATextbookof Geology,The World PressPvt.Ltd, Kolkata,638p*
6. *SomanK2001 Geology of KeralaGeological Societyof IndiaBangalore430p.*
7. *StewartRH2007Introduction toPhysical Oceanography353 p*
8. *Todd,DKandMaysLW.2004GroundwaterHydrogeology, Wiley*
9. *TyrrelL, GW 1978 The Principles of PETROLOGY, Springer, 368 p DOIhttps://doi.org/10.1007/978-94-011-6026-1*

Teaching and Learning Approach	**ClassroomProcedure(modeof transaction)** • DirectInstruction: Lecture,ExplicitTeaching,E-learning • Interactive Instruction: Active co-operative learning, Seminar,Group Assignments, Peer teaching and learning, Technology-enabled learning,Librarywork, Field visit
AssessmentTypes	**Modeof Assessment** A. Continuous Internal Assessment(40%) B. Internal Tests Assignments Seminar Presentation Review Report C. End Semester Examination(60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Science**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Environmental Chemistry and Pollution**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC703ES**					
Name of Faculty						
Course Summary& Justification	The course covers various forms of environmental pollution, such as air, water, and soil pollution, along with an exploration of different types and origins of pollutants, including emerging contaminants. The course delves into how pollutants interact within the environment and their pathways. Additionally, it outlines the different pollution monitoring techniques and strategies for managing different types of pollution.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	36	-	8	80
Pre-requisite	Students have basic knowledge of chemistry and an interest in Environmental Science.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Recognize and differentiate the types of water, air, and soil pollution and their sources.	U, E	2
2	Understand the impacts and control measures of water, air, and soil pollution.	U, E	2, 4, 8
3	Illustrate the different sampling equipment and able to conduct environmental sampling of various matrices.	A	4
4	Describeenvironmental analysisforvariouswater, air andqualityparameters & standards.	An, S	5
5	Explainthe Environmental factors influencing pollution	U, R	1
6	Describe the pollution by emerging contaminants and natural disasters.	U,R,I	1, 2

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Air and Noise pollution** Atmospheric chemistry and Factors affecting air pollution, Transport and diffusion of pollutants. Gas laws governing the behaviour of pollutants in the atmosphere, Effects of pollutants on human beings, plants, animals, materials and on climate. Identification of aeroallergens. Air-borne diseases and allergies, Air pollution control, Noise Pollution and control: Characteristics of noise, sources, Effects of noise, Standards, Measurement and control, Noise Pollution and control: Characteristics of noise, sources, Effects of noise, Standards	18	1,2,5
2	**Water and Soil pollution** Aquatic chemistry and water pollution, Measurement and control of Water pollution, Management of point and non-point sources of water pollution, water pollution control, Role of State and Central Pollution Control Boards, Soil/sediment Pollution: Soil quality parameters-Physico-chemical parameters of soil quality, factors affecting pollutants in the sediments – texture, pH, redox potential, organic carbon etc, Sedimentation rate and contamination profile, sediment pollution indices, Soil Pollution Control. Industrial waste effluents and heavy metals, their interactions with soil components. Soil microorganisms and their functions, Degradation of different insecticides, fungicides and weedicides in soil. Different kinds of, synthetic fertilizers (NP & K) and their interactions with different components of soil, radioactive waste treatment: Control measures	22	1,5,2
3	**Environmental Pollution monitoring** Monitoring-online and offline, Environmental sampling and analysis – stages (sampling, treatment, detection and interpretation), scope and criteria, Sampling – water, air and soil, equipment for air, water and soil sampling. Analysis – types and methods, Speciation, Certified reference materials Water quality parameters-physical, chemical and biological, analysis, Water quality standards, Tracers – dyes and isotopes in pollution monitoring; Ambient Air quality Monitoring, Air quality Standards-ambient and emission, Air sampling equipment. Methods of monitoring and control of air pollution SO2, NO, CO, CO2, Ozone, SPMPM2.5 & PM 10. Air quality index. Noise measurement; Soil/sediment sampling and monitoring. Soil quality standards. Methods for assessing pollutant contamination profile in the sediments – chronology and pollutant detection	24	3, 4
4	**Emerging contaminants** Emerging contaminants – definition, types and sources Sources and health impacts of PPCPs, POPS, PCCDS, PFAs, Dioxins, PCBs etc, Plastics pollution in the freshwater and marine ecosystems Natural disasters and Pollution	16	2,6

References

1. *Baxter, M. (2013). Social and Ethical Aspects of Radiation Risk Management,Vol.19, Editors: DeborahOughton SvenHansson.Elsevier(Pub.).Series:RadioactivityintheEnvironment.*
2. *Brady,N.C.(1996).TheNatureandPropertiesof Soil,10th Ed.,PrenticeHallofIndiaPvt.Ltd.*
3. *Cherimisinoff, N.P. (2001). Biotechnology forWaste and wastewater treatment, Prentice Hall ofIndiaPvt. Ltd.*
4. *HelmutMeuser(2010).ContaminatedUrbanSoils,Springer.*
5. *Luyben, W. L. Process Modeling Simulation and Controls for Chemical Engineers, Mc. Graw HillBookCo.*
6. *Mahajan,S.P.(1998).Pollutioncontrol inprocessindustries,TataMcGrawHill,NewDelhi.*
7. *Masters, G.M. (1998). Introduction to Environmental Engineering and Science 3rd ed. Prentice HallofIndia Pvt. Ltd.*
8. *MetcalfandEddy (2003).Wastewaterengineering:Treatment,Disposal,Reuse,4th edition. TataMcGrawHill, New Delhi.*
9. *MillerR.W.andDonalvee,R.L.(1997).SoilsinOurEnvironment,7th Ed,PrenticeHallofIndiaPvt.Ltd .*
10. *Nathanson,J.A.(2003). BasicEnvironmentalTechnology,4th Ed.,PrenticeHallofIndia Pvt.Ltd.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Field visit & analysis, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Conservation Biology**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC704ES**					
Name of Faculty						
Course Summary& Justification	This course allows the students to learn the fundamentals of biodiversity and conservation biology. Students will also get the knowledge and skills required to conserve biodiversity and prevent the extinction of species in the face of rapid increases in human impacts on the planet.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others includeCase studies, Library, fieldwork, seminar and assignment preparations, tests, research articles/ case reports, discussion etc.	36	36		8	80
Pre-requisite	As per the requirement of the course					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basic concepts of Biodiversity andConservation biology	R, U	1,2,4
2	Classify different sampling techniques in biodiversity estimation, its fieldlevel implementation and interpretation of results using different indices and methods.	U, An, E	2,4,5
3	Understand and evaluate the various initiatives for biodiversity conservation.	U,E	3,4,6,7
4	Discuss and examine the values and threats affecting biodiversity	An,E	2,3,4,6,7 ,8
5	Understand and explain the concept of natural history	E	1,4,6

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Biodiversity - An introduction** The evolution of biodiversity, Theories and Concepts of Biodiversity, Origin of species/speciation, The distribution of biodiversity on a macroscale	7	1
2	**Biodiversity Estimation** Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment, richness, density, frequency, abundance, evenness, diversity, biomass estimation; community diversity estimation: alpha, beta and gamma diversity; molecular techniques: RAPD, RFLP, AFLP; NCBI database, BLAST analyses.	18	1, 2
3	**Conservation of Biodiversity** In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries); Ex-situ conservation(botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks), role of local communities and traditional knowledge in conservation; Global Conservation initiatives -biodiversity hotspots; Conservation in South and Southeast Asia, National Conservation Action Plan, Landscape-level Conservation, Conservation Strategies, IUCN Red List categorization – guidelines, practice and application; Red Databook; ecological restoration; afforestation; social forestry; agro forestry; joint forest management; role of remote sensing in management of natural resources.	18	1,2,3
4	**Values and Threats of Biodiversity** Economic values; ecological and ecosystem services; Cultural, social, aesthetic, consumptive and ethical values of biodiversity. Threats: Natural and anthropogenic disturbances; habitat loss, habitat degradation and habitat fragmentation; invasive species; Pollution; climate change; pollution; hunting; overexploitation; deforestation; developmental activities; land use changes; overgrazing; man-wildlife conflicts; consequences of biodiversity loss**,** Endangered and Threatened species, IUCN, Red Data Book	17	1,2,3,4
5	**Introduction to Conservation Biology** History, Concepts and Background, Biogeography of India, Western Ghats, Wildlife biology, Restoration biology	10	1,3,4,5
6	**Natural History** Natural History in India, Animal Behavior, General Entomology, Ornithology, Mammalogy, Ichthyology, Herpetology, Basic understanding of common flora in Southern Western Ghats	10	1,3,4,5

References

1. *Ahmadullah, M and Nayar, M. P. 1987. Endemic plants of the Indian Region. Vol. I Botanical Survey of India.*
2. *Heywood, V. H. (Ed) 1995. Global Biodiversity Assessment (UNEP), Cambridge University Press, Cambridge.*
3. *Lewis, M. 2003. Inventing Global Ecology: Tracking the biodiversity ideal in India, Orient Longman. P369.*
4. *Martin, G.J. 1995. Ethnobotany - A methods manual. Chapman & Hall. Madras.*

5. *Maxted, N., B. V. Ford-Lloyd and J. G. Hawkes. 1997. Plant Genetic conservation- the insitu approach. Chapman & Hall, Madras.*
6. *Michael E. Soule and Bruce Wilcox, 1980. Conservation Biology: An EvolutionaryEcological Perspective.*
7. *Nair, S. C. Southern Western Ghats: A biodiversity conservation Plan, INTACH, New Delhi. P92.*
8. *Sutherland, W. J. 2004. The Conservation Handbook, Research, Management and Policy, Blackwell Science ltd. P278.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Lab course-I (Environmental Pollution and Geology)**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC705ES**					
Name of Faculty						
Course Summary& Justification	The course will enable students to understand various physico-chemical parameters determining water, air and soil quality and to carry out environmental sampling and analysis. The course will discuss various modern analytical techniques. After the programme, the students can do theinstrumental analysis ofwater, soil and air samples.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
		-	-	108	-	108
Pre-requisite	As per the requirement of the course					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basic principles of the analysis of water,soil and air quality parameters	R, U	1
2	Assessphysico-chemical parameters of water, soil and air	An	2,4,5
3	Describe the applications of various instrumentation methods and do the analysis of environmental samples using modern instruments.	U, A,An,E,S	4,5
4	Do environmental pollution (water, soil and air) monitoring	A, An, E,S	2-5

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Water quality** Analysis of COD, Sulphate, Sulphide, Potassium, Iron; Nutrient analysis (Nitrite, Nitrate, TN, Phosphate); Total and dissolved metals in water	20	1-4
2	**Soil/sediment quality** Available Nitrogen, Total Nitrogen, Available Phosphorous, Available potassium, Trace metals	19	1-4
3	**Air quality** Ambient Gaseous pollutant analysis – SOx, NOx, CO; Ambient particulate monitoring – SPM, RPM; Online monitoring of ambient air quality	19	1-4
4	**Instrumentation** Spectroscopy: Spectrophotometer- UV, Vis, FTIR, ICP-MS, Mercury analyser – CVAAS, Direct Mercury Analyser, CVAF; Chromatography: LC, IC, LC-MS, LC-QToF, GC-TCD,ECD,FID, GC-MS; Other equipment &Online monitoring instruments: TOC, Ambient Air Quality Monitoring System, Portable Water Quality Analyser, Portable Green House Gas analyser	50	1-4

References

1. *Abbasi S A, Water quality sampling and analysis, Discovery Publishing New Delhi*
2. *APHA (1995). Standard methods for the examination of water and wastewater. 19th edition American Public Health Association, Washington, DC*
3. *Christian Gary D, Analytical Chemistry, John Wiley& Sons New York*
4. *Conklin Alfred R. Introduction to Soil chemistry, analysis and Instrumentation, Jhon Wiley& Sons New york*
5. *Maiti, S.K. (2003) Handbook of methods in environmental studies, Vol. 2: Air, noise, soil, overburden, solid waste and ecology. ABD Publishers, Jaipur.*
6. *Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London*
7. *Marc Pansu, Jacques Gautheyrou, Hand book of soil analysis- Mineralogical, organic and inorganic methods, Springer, New York*
8. *Maria Csuros and Csaba Csuros, Environmental Sampling and Analysis for Metals, Lewis Publishers*
9. *Miroslav Radojevic and Vladimir N Bashkin, Practical Environmental Analysis, RSC Publishing*
10. *NEERI , Air quality monitoring, A course manual (Photostat), NEERI Nagpur*

Teaching and Learning Approach	Laboratory Practicals
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) Internal test Review of Book /Article Seminar Presentation Field visit report B. Semester End examination

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc. (EnvironmentalScience)**					
Course Name	**Field Study**					
Type of course	**Core**	**Credit Value**	**2**			
Course code	**IMSE706ES**					
Name of Faculty						
Course Summary& Justification	This course aims to increase the students environmental literacy level to build their concern and responsibility for the environment. Through this programme, students will learn how to conduct fieldwork in various ecosystems. It will also enable students to explore rocks and minerals and conduct hydrological assessments. Field visits to various forests, mangroves, wetlands,river, lake, marine and other ecological important ecosystems will teach students about the role and services provided by these systems in the environment. Besides, the students will get more exposure to the ecological and environmental field sampling techniques like quadrate study.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
		-	18	36	-	54
Pre-requisite	As per the requirement of the course					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basics of samplingof water, sediment, soil and air	U	1
2	Conduct the sampling of air, water and soil	A, An ,E,S	4
3	Conduct the sampling of aquatic organisms	An, E, S	4
4	Acquire more knowledge regarding the structure and functions of various ecosystems	U	1
5	Carry out the assessment of various ecosystem services including biodiversity, carbon sequestration, wildlife census etc.using different ecological sampling techniques	A, An,E, S	4
6	Able to identify various rocks and minerals and conduct geological field survey	U,A	1

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Water Quality Monitoring** Water sampling,Sediment sampling,Sampling of planktons and benthos,Sampling of other aquatic organisms	13	1,2,3
2	**Soil & Air quality monitoring** Soil sampling,Air sampling – particulate and gaseous sampling,collection of weather data	14	1,2
3	**Ecology** Collection of samples for plant taxonomy,biodiversity assessment, carbon sequestration study,sampling of aquatic organisms,wild life Census	14	4,5
4	**Environmental Geosciences** Identification of rocks and minerals in the field,Measuring strike and dip of rock formations,Data collection for Rose diagram (rocks),Basic map reading.	13	6

References

1. *Abbasi S A, Water quality sampling and analysis, Discovery Publishing New Delhi*

2. *Christian Gary D, Analytical Chemistry, John Wiley& Sons New York*

3. Conklin Alfred R. Introduction to Soil chemistry, analysis and Instrumentation, John Wiley &Sons New York

4. Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London

5.Manly, B. (2014). Standard Sampling Methods and Analyses. Introduction to Ecological Sampling, 22-47.

5. Marc Pansu, Jacques Gautheyrou, Hand book of soil analysis- Mineralogical, organic and inorganic methods, Springer, New York

6. Maria Csuros and CsabaCsuros, Environmental Sampling and Analysis for Metals, Lewis Publishers

7. Miroslav Radojevic and Vladimir N Bashkin, Practical Environmental Analysis, RSC Publishing

8. NEERI , Air quality monitoring, A course manual (Photostat), NEERI Nagpur

Teaching and Learning Approach	Group Assignments Authentic learning, Library work and Group discussion, Presentation by individual student/ Group representative; Fieldwork and field visits
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (CIA) Internal test Review of Book /Article Seminar Presentation Field visit report B. Semester End examination

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc. (EnvironmentalScience)**					
Course Name	**Research Methodology**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC707ES**					
Name of Faculty						
Course Summary& Justification	The course deals with the general research methodology and statistical practices for environmental science.					
Semester	**VII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	36	-	8	80
Pre-requisite	Basic research aptitude and knowledge in statistics					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the various research methods and statistical techniques for doing research.	U	5,8
2	Infer the literature, data analysis and resultpresentation procedures.	U	5,8
3	Help to develop a testing hypothesis for research	A	5,8
4	Appraise various statistical techniques for doingresearch	E,S	5,8
5	Interpret and explain research articles in their academic discipline.	U	5,8
6	Apply statistical software for data analysis	A,S	5,8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Research Methodology** Meaning- Objectives- motivation- Significances of research, Types of research, Research methods and methodology, Research and Scientific Method, Criteria of Good research, Problems of researcher	6	1,2
2	**Selection of the problem** Criteria for selection of problem and evaluating problems, Statement of problem formulation and definition; Research design: Meaning, need for research design, Features and important concepts relating to research design, Different research design, Basic principles of experimental design.	7	1,2,4,5
3	**Survey of literature** Different methods of surveying literature, different sources of information, internet, search engines, web sites, recording surveying information; Hypothesis: Nature, types and sources of hypothesis, characteristics of a good hypothesis.	6	2,3
4	**Sampling** Unit of sampling, population: techniques, characteristics of good samples, different types of sample, sampling errors and ways to reduce them; Collection and analysis and interpretation of data: Procedure of data collection, scoring of data, tabulation, editing and analysis and interpretation of data; Research Report: Composition, pagination, Title pages, Systems of indicating references, Bibliography, Appendices	13	1,2,4,5, 6
5	Mini project for data analysis	6	5,6
6	**Fundamental Statistics** Introduction – Importance and limitation; Classification and Tabulation of data; Graphical Representation	6	1,2
7	**Measures of Central Tendencies** Mean, Median and Mode; Measures of Dispersion - Range, Standard Deviation and Coefficient of Variation; Moments, Skewness and Kurtosis, Correlation and Regression: Scatter diagrams – Karl Pearson‘s Coefficient of correlation – Rank correlation – Linear and Curvilinear regressions; Probability: Frequency approach- Addition and multiplication theorems- Binomial, Poisson and Normal Distribution- Probit analysis (Graphic Method only); Testing of Hypothesis: Null and Alternative Hypothesis – Two types of error – Level of significance Test based on t, Z, F ,Chi –square and Analysis of Variance – one-way, two-way, three-way analysis	23	3-6
8	**Application of Computer in Statistics** Data analysis using packages - MS excel	13	5,6

References

1. *Ahuja Ram, Research Methods, Rawath Jaipur.*
2. *Babbie Earl, Research methods in sociology, Cengage Learning Australia.*
3. *Denscombe Martyn, The good research guide: for small scale social research projects, Viva Books New Delhi.*
4. *Devendra Thakur, Research methodology in social science, Deep & Deep Publications New Delhi*

5. *Gurumani N, Research methodology for Biological Sciences, MJP Publishers Chennai*
6. *Holmes Debbie Moody Peter Dine Diana, Research methods for the biosciences, Oxford New york.*
7. *Kothari C R, Research methodology: methods and techniques, Wiswa Prakashan New Delhi.*
8. *Mohankumar P S , Handbook on research methodology, Right Publishers Kudanechoor*
9. *Narwal S S Dahiya S S Singh J P, Research methods in Plant science, Allelopathy Vol 1, Soil analysis, Scientific Publishers Jodhpur.*
10. *Prabhakar V K, Research methodology and system analysis, Anmol NewDelhi*
11. *Santosh Gupta, Research methodology and statistical techniques, Deep & Deep Publications New Delhi*
12. *Barnett Vic, Environmental statistics, methods and applications. John Wiley & Sons New York.*
13. *Gupta S P, Statistical methods, Sultan Chandh New Delhi*
14. *Kozak Antal Kozak Robert A Staudhammer Christina L Watts Susan B, Introductory Probability and Statistics, applications for forestry and the natural sciences, Cab International Wallingford.*
15. *Levin Richard I Rubin David S, Statistics for Management, Edition 7, P H I New Delhi 16. Miller Jane, Statistics for advanced level, Ed.2, University Press Cambridge.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** C. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report D. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Analytical Techniques and Instrumentation**					
Type of course	**Core**		**Credit Value**		**4**	
Course code	**IMSC801ES**					
Name of Faculty						
Course Summary& Justification	The course will discuss on various classical and modern analyticaltechniques. After the program, the students will able to do thegravimetric, volumetric, and instrumental method of analysis.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem solving sessions, Seminars, independent learning etc..	54	36	-	10	100
Pre-requisite	Students have basic knowledge and interest in instrumentation and labwork.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Explain the analytical errors and describe clean analysis.	R	4, 5, 6
2	Explain gravimetric, volumetric, spectroscopic and chromatographic analysis	R, U	4
3	Do gravimetric, volumetric, spectroscopic and chromatographic analysis	An,S	4, 2
4	Explain the applications of gravimetric and volumetric methods	U,R	4, 2
5	Describe the applications of spectroscopic methods	U, E	4
6	Describe the applications of chromatographic methods	U, E	4
7	Explain radiation detectors	U, E	4

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction** Significant figures, Accuracy and precision; Types of errors- random and systematic errors, Standard deviation; Precipitation from homogeneous solutions, Organic and inorganic precipitating agents	14	1
2	**Gravimetric methods** Mechanism of formation of precipitates, Characteristics of ideal precipitate, Methods to improve filterability and minimizing adsorbed impurities; Precipitation from homogeneous solutions, Organic and inorganic precipitating agents; Application of gravimetric methods	20	2, 3
3	**Volumetric methods** Molarity, Normality, Standard solutions, End point; Acid-base titrations – titration curves, theory of indicators; Complexometric titrations-EDTA titrations-applications; Iodometry, Iodimetry, Colorimetric titrations	16	2, 3
4	**Spectrochemical methods** Electromagnetic spectrum, Interaction of light with matter/molecule; Fundamentals of molecular spectroscopy; Wavelength selectors: Filters and Monochromators, Radiation detectors and Transducers; Mass spectrometry; Atomic Absorption spectroscopy (AAS), Inductively coupled plasma mass spectrometry (ICP-MS) -principle and applications; Microwave, IR, Electronic, Raman, NMR and ESR spectroscopy-principle; SEM,TEM- instrumentation and applications.	24	2, 3, 5
5	**Radiation detectors** Dosimetry, Geiger Muller Counter, Scintillation Counter; Electrochemical Methods: pH meter- Glass and reference electrodes, Conductivity meter	10	7
6	**Chromatographic Techniques and environmental applications** Paper Chromatography, Thin Layer Chromatography, Column Chromatography, Ion Chromatography; Gas Chromatography (GC), GC-MS; Liquid Chromatography, High Performance Liquid Chromatography (HPLC), LC-MS, LC-MS/MS	16	2, 3, 6

References

1. *APHA (1998), Standard Methods for the Examination of Water and Waste water, 20th edition, Washington DC*
2. *McBride, M.B. (1994), Environmental Chemistry of Soils, Oxford University Press, New York*
3. *Skoog, D.A. and Leary, J.J. (1992), Principles of Instrumental Analysis, 4thedition, Saunder's College Publishing, Fort Worth*
4. *Suchla, G (Ed.) (1987) Vogel's Qualitative Inorganic Chemistry, ELBS.*
5. *Willard, H.H., Merrit, L.L., Deen, J.A. and Settle, F.A. (1986), Instrumental Methods of Analysis, (Indian Reprint), CBS Publishers and Distributors, New Delhi*
6. *Skoog, West, Holler Crouch, Fundamentals of Analytical Chemistry, 8th edition, Cengage Learning J.Throck Watson, Introduction to Mass Spectrometry, 3rd edition, Lippincott-Raven publishers, Philadelphia, New York*
7. *Gary D. Christian. Analytical Chemistry, 5th edition, John Wiley and Sons*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Environmental Biotechnology and Waste Management**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC802ES**					
Name of Faculty						
Course Summary& Justification	Application of Biotechnological methods in controlling air, water and soil pollution. Understanding the blend of Ecology and Engineering in wastewater remediation and solid waste management. The concept of Ecological Sanitation (ECOSAN) is also introduced in this course.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	36	-	8	90
Pre-requisite	Studnts having basic knowledge and interest on instrumentation and labwork.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the basics of molecular biology andenvironmental biotechnology and its relevance.	U, R	4
2	Understand the Biotechnology techniquesapplicable to combat air, soil and water pollution. To assessthe efficiency of different wastewater treatment techniques.	U,A	4, 5
3	Classify different kinds of biotechnological applications inAgriculture like organic fertilisers and biopesticides.Understand the concept of Ecological Engineering – a blendof Ecology and Engineering to control water pollution. To apply the appropriate bioplastics producing technique toovercome the plastic menace	U,A,S	4, 5
4	Understand different solid waste management steps; toassess their potential at present and future. To describethe need for zero waste concept	U,R, E	2, 4
5	Explain the importance of Ecological Sanitation – a newemerging concept of circular economy in sanitation sector.	E, C, I	4, 6

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Cell Technology and Biotechnology** Cell: Structure and function – Prokaryotes and Eukaryotes. Nucleic Acids, Central dogma - Protein synthesis, rDNA technology. Fermentation Technology; Plant tissue culture techniques; Environmental Biotechnology: an overview	14	1
2	**Biotechnological Methods in Pollution Control** Air pollution control: Bio-desulphurisation of coal, Green belts; Air pollution control: Bio-desulphurisation of coal, Green belts; Water pollution control: Aerobic and Anaerobic wastewater treatment Systems; Bioremediation: Soil / land contaminated with oil spills, PCBs, PAHs; Bioremediation technology; Phytoremediation; Biosensors: Concept and principle, Biosensors for environmental monitoring.	22	1, 2, 3
3	**Emerging Trends in Environmental Biotechnology** Agrobiotechnology : Plant genetic engineering – role of rDNA technique; transgenic plants - GM crops, Biopesticides and Biofertilizers; Ecological Engineering: Constructed / Artificial wetlands, Nutrient Film Technique (NFT); Biodegradable plastics – PHBs and PHAs.	16	3
4	**Solid Waste Management** Municipal Solid Waste: Types, sources, properties and impacts; Techniques for treatment / processing: Concept of three 'R's, Thermal processes – incineration, Pyrolysis, RDF. Biological processes – Anaerobic digestion, Composting and vermicomposting; Disposal techniques: Landfills – design, operation and management. Hazardous waste management; Concept of Zero waste**.**	20	4
5	**Ecological Sanitation** Conventional sanitation : a linear flow system – its limitations; Eco San – Circular flow and closing the loop : concept, goals and advantages; Eco San for human night soil management: Dry Toilets, Composting Toilets UDDT, UDFT; Grey water management; Eco San - Human Health and Food Security.	18	4, 5

References

1. *Abbasi, S.A. 1998. Environmental Pollution and its Control ,Cogent International, Pondicherry*
2. *Abbasi, S.A., Ramasamy, E.V. 2001. Solid Waste Management with Earthworms Discovery Publishing house, New Delhi.*
3. *Abbasi, S.A., Ramasamy, E.V.1999. Biotechnological Methods of Pollution Control. Orient Longman, (Universities Press of India Ltd.) India, 168.*
4. *Chandra, R., Dubey, N. K., Kumar, V. 2017. Phytoremediation of Environmental Pollutants, CRC Press.*
5. *Chatterji.A.K.2002. Introduction to Environmental Biotechnology. Prentice-Hall of India Private Limited. New Delhi.*
6. *Cheremisinoff .N.P.2001. Biotechnology for the Waste and Waste Water Treatment. Prentice-Hall of India. New Delhi.*
7. *Cherry, P. M. 2016. Solid and Hazardous waste management. BCS publishers and Distributors. New Delhi*
8. *Clark, D.P. and Pazdernik.N.J.2009. Biotechnology Applying the Genetic Revolution. Elsevier. London*

9. *Das, S. 2014. Microbial biodegradation and bioremediation, Elsevier. London.*
10. *Edwards, C.A. 2004. Earthworm Ecology, CRC Press, London.*
11. *Freeman, .H.M. 1998. Standard book of Hazardous Waste Treatment and Disposal, McGraw Hill, New York.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**		
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**		
Course Name	**Environmental Economics and Sustainable Development**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC803ES**		
Name of Faculty			
Course Summary& Justification	The course delves into comprehending the intricate relationships among human activities, economic systems, and the environment. It addresses the growing human population, patterns of natural resource consumption and underscores the significance of both sustainable development and consumption. Additionally, it highlights the role of education in promoting environmental awareness and fostering sustainable development.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc.	36	36	-	8	90

Pre-requisite	Students havean interest on socially oriented environmental matters, such as population, resource consumption and sustainable development.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Explain the basics of concepts and theories of environmental economics and sustainable development	U	6
2	Distinguish various problems that threaten sustainability	A	7
3	Identify methods, tools, and techniques for sustainability	U, R	5
4	To build at the individual level qualitative and quantitativeskills/capabilities for bringing essential environmentalconsiderations into economic planning, policies and developmental projects.	C	8
5	Describe the environmental problems and its impacts	An,E	2
6	To synthesize the new field of environment and economicsin an holistic approach towards solution of environmentalproblems	C	6, 8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Integrating Environment and Economics** History: The evolution of economic and environmental thinking. Elementary economic principles applied in environmental economics - theory of consumption, production, prices, market (equilibrium and failure) Market, policy, and environmental degradation; Economy, Environment – Interface: Material Balance Principle Energy	12	1
2	**Fundamental concepts and theories in Environmental Economics** Environmental economics – meaning, scope and limitations; Basic Theory of Environmental Economics; Environmental quality as a public good and its efficient level; Economic efficiency, Property Rights, Market failure and externalities - taxes, permits externalities as public goods, internalizing externalities, Coase's Theorem and its Critique; Welfare economics: Welfare aspects of Environmental Economics - Principle of maximum social welfare - Pareto Criterion	22	1, 3, 4
3	**Environmental and Natural Resources (energy and water) Accounting** Population and environment; Global Issues – Climate Change , Resource Depletion, Waste management etc; Natural Resources Management: Brown, Green and Blue Economies; Carbon trading, Emissions trading and Clean Development Mechanisms; Circular Economy : A futuristic approach; Environmental Policies	10	5,3
4	**Sustainability and Sustainable Development** From problems to crises- Depletion of resources and environmental degradation; Sustainable Development: Strategies and Policies; Sustainable human development index, Sustainability pillars; Gandhian model of sustainable development; Sustainable development goals and achievements.	16	2, 3, 4, 6
5	**Sustainable Consumption** Definition, importance, relevance for developing countries - Difference between Sustainable Consumption from Sustainable Development and Sustainable Production - key issues -UN Guidelines Sustainable Consumption; Sustainable production and Sustainable consumption; Sustainable consumption Tools; Sustainable living and values	20	1, 3
6	**Education for Environment and Sustainable Development** Environmental education; Education for Sustainable Development; Education for sustainable consumption; Eco – School.	10	1, 5

References

1. *Bowers, J. (1997). Sustainability and Environmental Economics. Longman, Singapore.*
2. *Brown, L. R. (2001). Eco-Economy. Earth Scan Publications, London.*
3. *Hackett, S. C. (1998). Environmental and Natural Resource Economics. M. E. Sharpe, London*
4. *Hanley, Nick; Spash, Clive L., (1993). Cost-benefit analysis and the environment, Edward Elgar.*
5. *Heal. G. M. (1998). ―Interpreting Sustainability‖ in Sustainability: Dynamics & Uncertainty, Kluwer Academic Publ., 34-44*
6. *Jepma C.J. & M. Munasinghe, (1998). Climate Change Policy – Facts, Issues and Analysis, Cambridge University Press, – Chapters 1 & 8. 110-159*

7. *Karpagam, M. (1991). Environmental Economics. Sterling Pub., New Delhi*
8. *Mohan Munasinghe, (1996). ―Sustainable Energy Development: Issues and Policy‖ – in Kleindorfor P. R. et. al (ed.) Energy, Environment and Economy: Asian Perspective, Edward Elgar, 45-65.*
9. *Muralivallabhan T. V., Dimensions of Sustainable Economic Development, Unma Pub., 2005*
10. *Murty, M.N.; James, A.J. & Misra, Smita, (1999). Economics of water pollution: the Indian experience, Oxford University Press.*
11. *Natalia Mirovitskaya and William Ascher., Guide to Sustainable Development and Environmental policy., Duke University Press, London, 2001.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Environmental Microbiology**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC804ES**					
Name of Faculty						
Course Summary& Justification	This course aims to give students a basic understanding ofenvironmental microbiology, including the functional diversity ofmicroorganisms in the environment and how it affects human welfareand ecosystem health, microbial interactions with pollutants in theenvironment, and microbial pathogens' fate in the environment.Microbial habitats, identification of microorganisms and theiractivities in the environment, microbial biogeochemistry,bioremediation, and water quality are among the topics discussed.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	36	-	8	90
Pre-requisite	Students are interested in microbes and eager to know their characteristics and application in environmental science.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Various microorganisms in the environment have their basic characteristics.	R	1
2	Understand and apply the various techniques for isolating and characterising microorganisms from environmental compartments.	U,A, An	4
3	Understand and evaluate the role of microorganisms in various biogeochemical cycles and other environmental processes	U, E	4, 8
4	Understand and analyse the role of microorganisms in various diseases	U, An	4
5	Analyse and apply the role of microorganisms in various environmental applications	An, A,C,S	4

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Microorganisms in the environment** Introduction, scope and brief history; Microorganisms in the environment– bacteria, fungi, protists, algae and viruses - characteristic features and their role in the environment; Morphology and the basic structure of bacteria - plasma membrane, cell wall, flagella , pili, capsule, slime layer, glycolcalyx, nucleoid, ribosomes, cytoplasmic inclusions; Microbial habitat in air, water and soil; Basics of Gram staining	16	1
2	**Isolation and characterisation of bacteria from the environment** Pour plate and streak plate method. Use of different media and culture techniques; Pure culture techniques – streak plate method – quadrant streak and continuous streak methods. Maintenance of bacteria on agar slants and long term preservation as glycerol stock; Outline of microbial taxonomy – phenetic and phylogenetic classification. Bergey‘s manual of determinative bacteriology; PCR technique - Principles and applications.	20	2
3	**Microorganisms and environmental processes** Role of microorganisms in biogeochemical cycles with special reference to carbon, nitrogen, phosphorus and sulphur cycles; Microorganisms in extreme environments – Archaebacteria – Psychrophiles, Thermophiles, Halophiles, Barophiles, Methanogenes etc; Soil microbial communities and their association with plants – bipartite and tripartite associations - rhizosphere microflora, mycorrhizae – ecto and endomycorrhizae – VAM – actinorrhizae; mycorrhizae – ecto and endomycorrhizae – VAM – actinorrhizae.	20	3
4	**Microorganisms and disease** Water and air borne pathogens; Diseases caused by microorganisms and their symptoms – routes of infection and control measures; Microbial indicators of water quality – coliforms, faecal coliforms, Escherichia coli and faecal streptococci.	16	4
5	**Applications of microorganisms in environment management** Wastewater treatment; Application of genetically engineered organisms in the clean-up of the environment; Role of microorganisms in bioremediation; Pollutant-microbe interactions – metal-microbe interactions.	18	5

References

1. *Abigail A Salyers and Dixie D Whitt 2001. Microbiology - Diversity, disease and the environment. Fitzgerald Science Press, Maryland, USA.*
2. *Claus, W.G. 1989. Understanding microbes: A Laboratory Text book for Microbiology. W. H. Freeman and Co., New York.*
3. *David C Sigee 2005. Freshwater Microbiology - Biodiversity and dynamic interactions of microorganisms in the aquatic environment. John Wiley and Sons Ltd. England.*
4. *Eweis, J.B., Ergas, S.J., Chang, D.P. Y. and Schroeder, E.D. 1998. Bioremediation Principles, McGraw Hill Publ.*
5. *Freifelder, D. 1987. Microbial Genetics. Johns and Barlett Publishers Inc.*
6. *Hawkins, J.D. 1996. Gene Structure and Expression, Third edition. Cambridge University Press, Oxford.*

7. *Jacquelyn G Black 2005. Microbiology - Prinicipes and Explorations - 6 th Edition. John Wiley and Sons, USA.*
8. *Lewin, B. 1998. Genes VI. Oxford University Press, Oxford.*
9. *Lynch, M. and Hobbie, J.E. 1988. Microorganisms in Action - Concepts and applications of Microbial Ecology. Blackwell Scientific Publications.*
10. *Pelcazr, M.J., Reid, R. and Chan, E.C.S. 1996. Microbiology. Tata Mc Graw Hill Publishing Co. Ltd., New Delhi.*
11. *Prescott, L.M., Harley, J.P. and Klein, D.A. 2006. Microbiology. WCB Publishers. (Latest editions available)*
12. *Salle, A.J. 1961. Laboratory Manual of Fundamental Principles of Bacteriology. Mc Graw Hill Book C, New York.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Filed visit and sample analysis, Library work.
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Lab course-II (Ecology, Environmental Microbiology, Remote Sensing and GIS)**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC805ES**					
Name of Faculty						
Course Summary& Justification	This course provides various methods for biodiversity assessment. It will also enable students toidentify microbial pollution of water and soil environment. The studentswill be able to identify and isolate microbes from the environment. Thestudents will also get acquainted with the RS & GIS technique andbecome able to do map preparation and other applications of GIS.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	-	-	108	-	108
Pre-requisite	Students are interested in microbes and eager to know their characteristics and application in environmental science.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the importance of ecological and microbiological assessment and application of remote sensing and GIS in environmental monitoring.	U, R	2, 4
2	Carryout Ecological assessment	An, E	1
3	Identify and isolate various microbes from the environment	An, E, S	4
4	Createmap using GIS platform and assess remotesensing data	An, C, I	2, 8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Ecology** Estimation of primary productivity; Identification of common phytoplankton, zooplankton, macrophytes, exotic fish, Plants and invertebrates, Biodiversity assessment: Quadrate method, Observation of ecological issues – Pollution sites, solid waste management, eutrophication and deforestation patches	28	1, 2
2	**Environmental microbiology** Preparation and characterization of bacteriological media – use of autoclave and hot air oven for sterilization; Isolation and enumeration of microorganisms in environmental samples (soil and water); Pure culture techniques – quadrant streaking, continuous streaking methods; Use of compound microscope; Staining techniques – Simple stain, Gram stain Endospore staining; Detection of bacterial motility – hanging drop method, use of semi-solid agar; Basic biochemical test for characterization of bacteria – Oxidase test and catalase test and oxidation/ fermentation (O/F) test; Membrane filter technique to detect faecal coliforms in water and Escherichia coli Indole, Methyl Red (MR), Voges-Proskauer and Citrate (IMViC) tests for the 85characterization of *E. coli.*	38	1, 3
3	**Remote sensing and GIS** GIS- Creation of Digital Elevation Model, Understanding various freely available global DEMs; Raster Analysis in GIS (3D analysis tools- Line of sight, Line/ Area Elevation profile); Generation of Slope, Aspect, Hillshade, View shed, Curvature; Reclassification and Ranking; Raster Calculator; Weighted Overlay analysis; Raster Interpolations (IDW, Kriging); Weighted Overlay RS& Image processing- Understanding Geometric and Radiometric Errors; Geometric and Radiometric Corrections; Sub seting the Image; Visual Interpretation of satellite image; Digital Image Classification (Supervised/ Unsupervised); Image Enhancement Techniques (EVI, NDVI)	42	1, 4

References

1. *APHA (1995). Standard methods for the examination of water and wastewater. 19th edition American Public Health Association, Washington, DC*
2. *Aileen R. B., A. Jon, K., Muekrrcke, P.C. and Juliana O. M. 2016. Map Use: Reading, Analysis, Interpretation, eighth editions*
3. *David, S., Nathan, S., Christian, H., Steven, M., Tim, O. AND Thomas, B. 2018. Understanding GIS, fourth edition. ESRI Press*
4. *Gina, C. 2018. The GIS 20: Essential Skills, third edition. ESRI Press.*
5. *Gregory, I. 2007. Historical GIS: technologies, methodologies and scholarship. Cambridge, UK; New York: Cambridge University Press*
6. *Mamata Tomar, Quality Assessment of Water and Waste Water, Lewis Publishers London*
7. *Maiti, S.K. (2003) Handbook of methods in environmental studies, Vol. 2: Air, noise, soil, overburden, solid waste and ecology. ABD Publishers, Jaipur*
8. *Samantha, L. and Andrew, L. 2015. Practical Handbook of Remote Sensing. Routledge, Taylor and Francis.*

Teaching and Learning Approach	Laboratory practicals
Assessment Types	A. Continuous Internal Assessment (CIA) Internal test Review of Book /Article Seminar Presentation Field visit report B. Semester End examination

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (EnvironmentalScience)**		
Course Name	**Ecotoxicology**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSC806ES-1**		
Name of Faculty			
Course Summary& Justification	The course's major goal is to provide students with the knowledge andskills necessary to assess the destiny of pollutants in the environmentand their impacts on various biological organisation levels. The conceptual framework established throughout the ecotoxicology course will be expanded and applied to that goal.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	18	-	6	60

Pre-requisite	Students havean interest in the toxicity and effects of pollutants.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the sources and fates of chemicals in the environment	U	1
2	Explain mechanisms for adverse effects of chemicals	U	4
3	Estimate the risk for adverse effects of a chemical ondifferent biological organisation levels based on knowledgeabout the toxicity, degradability, and bioavailability of thechemical	An, E	2
4	Do toxicological testing of environmental pollutants	An	2
5	Explain food security in terms of contamination of food and control measures.	U	2
6	Explain the toxicokinetics and toxicodynamics	U, E	4

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Toxicants and ecosystem** Toxicants – organic and inorganic; Toxicants – entry into the environment, cycles and residence time; Transboundary movement of pollutants- factors affecting; Global environmental pollutants; Routes of exposure to humans – food, occupation, environment.	12	1
2	**Toxicants and their effects** Effects of toxicants on populations and communities; Toxicity of pesticides, metals, radioactive minerals, fluorides, chemical fertilizers and air pollutants – cellular and molecular level; Toxicokinetics and toxicodynamics; Damage process and action of toxicants – exposure, uptake, transport, storage, mechanism of action in plants and mammals; Toxicants in the food chain- Accumulation and magnification Multilevel trophic interactions and non-trophic interactions; Acute and chronic effects, Occupational hazards and diseases; Toxicity of biohazards.	20	2, 3, 6
3	**Toxicity testing and indicators** Principles of toxicity testing, Factors to be considered in toxicity testing; Methods of toxicity evaluation at the cellular and molecular level by in vitro and in vivo methods; Ecotoxicological testing methods – single species testing, microcosms; Bioindicators, lacustrine communities as indicators of ecosystem stress; Biosensors– concept and approach; Biomarkers- classification, relationship of biomarkers to adverse effects	20	3, 4
4	**Food Security** Concept of food security, food systems and public health; Interrelation between diet, food production, the environment, population and resources; Toxicants in food	8	5

References

1. *Ballantyne, B., Marris, T. and Turner, P. (Ed.). 1995. General and applied toxicology (Abridged edition), Macmillan Press*
2. *Cairns Jr., J. and Niedrelehner, B.R., (Ed.). 1994. Ecotoxicological toxicity testing – Scale, complexity relevance. Lewis publishers.*
3. *Cralley, L.V., Atkins, P.R., Cralley L.J. and Clayton (Ed.). Industrial environmental health- the worker and the community*
4. *Freedman B (Ed.). 1995. Environmental ecology – the ecological effects of pollution, disturbances and other stresses.*
5. *Levy B.S. and Wegman D.H. (Ed.). 1995. Occupational health- recognizing and preventing work related disease. Little Brown and Co.*
6. *Niesink, JM., DeVrries, J. and Hollinger, M.R. (Ed.) 1996. Toxicology – principles and applications. CRC Press.*
7. *Nurenberg H.W. (Ed.) 1985. Pollutants and their ecotoxicological significance. John Wiley & Sons*
8. *Ramada F., (Ed.) 1997. Ecotoxicology, John Wiley & Sons 9. Richardson M. 1995. Environmental Toxicity assessment. Taylor and Francis Ltd.*
9. *Stine K.E. and Brown T.M. 1996. Principles of toxicology*
10. *Yu M. 2001. Environmental toxicology-impacts of environmental toxicants on living system,*

Lewis Publishers

11. Grosby DG. 1998. Environmental toxicology and chemistry, Oxford University Press

12. Wright D.A. and Welbourm P. 2002. Environmental Toxicology, Cambridge University Press

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work.
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**					
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**					
Course Name	**Water Resources Management**					
Type of course	**Elective**		**Credit Value**		**2**	
Course code	**IMSC806ES-2**					
Name of Faculty						
Course Summary& Justification	This course allows the students to learn the fundamentals of water resources and its distribution. This course helps to identify the major causes of water resource depletion and the different parameters for water quality monitoring. The major plants and steps by Government and non-Government organizations for water resource management are also included.					
Semester	**VIII**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	18	-	6	60
Pre-requisite	Students havebasic knowledge of natural resources					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the sources and types of water resources	R,U	1
2	Understand the different drivers of water resource depletion and current trends.	U,E	2, 3
3	Do different physicochemical parameters that determine the water quality status	An,S	4
4	Understand the different management practices for the sustainable utilization and minimize the depletion of water resources.	U,A	4
5	Describe the role of individuals, Government and NGOs in water conservation.	U,A,I,Ap	6

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction to water resources** Sources and types of water; Properties of water as a resource; hydrological cycle; classification of water resources (oceans, rivers, reservoirs, lakes and wetlands).	10	1
2	**Depletion of water resources** Causes and trends of depletion of rivers, lakes and estuaries, oceans; Evidence of water resource depletion: Eutrophication, coral bleaching, water pollution, saline water intrusion, groundwater depletion, microplastic pollution.	12	2
3	**Water analysis** Methods of water quality and quantity-pH, temperature, salinity, total solids, turbidity, dissolved oxygen, BOD, COD.	8	1, 3
4	**Water management** Global Water Budget, global water availability, depletion of water resources, Interrelation of water resources with other natural resources and the environment; Watershed management; Irrigation water management; Integrated Water Resources Management (IWRM); Concept of sustainable water resources development; Global Efforts - water resource management, Local water organisations; World water organisations; UN, GWP, WWC, etc.	20	1, 4
5	**Conservation of water resources** Role of governments, NGOs; Individual, societal and national efforts in water protection, sustainable water management plans	10	5

References

1. *Abbasi, S.A. (2001) Water resources projects and their environmental impacts. Discovery publishing house, New Delhi.*
2. *Gangstad, I. (1990). Natural Resource management of water and land. Van Norstrand Reinhold, New york.*
3. *Petak, W.J and Atkisson, A.A. (1982). Natural Risk Hazard Assessment and Public policy. Springer- Verlag, New York.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Library work.
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

School Name	**Institute for Integrated programmes and Research in Basic Science (IIRBS)**		
Programme	**Five Year Integrated M.Sc.(EnvironmentalScience)**		
Course Name	**Sanitation and Health**		
Type of course	**Elective**	**Credit Value**	**2**
Course code	**IMSC806ES-3**		
Name of Faculty			
Course Summary& Justification	This course depicts the relationship between environmental sanitation and health by detailing the different health effects associated with improper sanitation and climate change. This course also unveils the different management plans adopted to maintain sanitation, especially through sustainable development.		
Semester	**VIII**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	18	-	6	60

Pre-requisite	Students havebasic knowledgeand interest in sanitation and health care.

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the concept and current situation of sanitation	R,U	1
2	Illustrate the impacts of sanitation on flora, fauna and human beings.	U,E	2
3	Depict the successful sanitation approaches globally and the role of the health sector in maintaining sanitation.	U,A,Ap	4
4	Understand the effects of climate change and resultant pollution over sanitation.	U,E	3
5	Evaluate the goals of sustainable development and its importance in sanitation maintenance.	E,Ap	5

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Sanitation and Health** Concept, need, constraints; and Current situation- Global and National	10	1
2	**Impacts of sanitation problems** Humans- Water and sanitation related diseases, respiratory infections, under nutrition, floral communities- impacts on growth and yield, fertility of soil and water availability, Fauna – diseases, reduced vulnerability	12	1, 2
3	**Management strategies** Successful approaches to sanitation-strategies; Role of health sector; Global experience in improving sanitation and hygiene	8	1, 3
4	**Health and sanitation** Climate change and diseases; Epidemiology and health ecology; Epidemiological diseases due to pollution problems; Health effects of cosmetics and drugs; Health risk assessment of toxic chemicals; Ecological risk assessment	20	1, 4
5	**Sustainable development and sanitation** View of sustainable development on sanitation problems, United Nations SDP - Clean water and sanitation; Roles of governments in implementing safe and healthy sanitary plans.	10	1, 5

References

1. *Ballantyne, B., Marris, T. and Turner, P. (Ed.). 1995. General and applied toxicology (Abridged edition), Macmillan Press*
2. *Cairns Jr., J. and Niedrelehner, B.R., (Ed.). 1994. Ecotoxicological toxicity testing – Scale, complexity relevance. Lewis publishers.*
3. *Grosby DG. 1998. Environmental toxicology and chemistry, Oxford University Press*
4. *Wright D.A. and Welbourm P. 2002. Environmental Toxicology, Cambridge University Press*
   Yu M. 2001. Environmental toxicology-impacts of environmental toxicants on living system, Lewis Publishers

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments,Peer teaching and learning, Technology-enabled learning, Field analysis,Library work.
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M.Sc. (Environmental Science)**					
Course Name	**Resource Management**					
Type of course	**Core**		**Credit Value**		**4**	
Course code	**IMSC901ES**					
Name of Faculty						
Course Summary& Justification	This course allows the students to learn the fundamental theories and concepts of Resource Management.					
Semester	**IX**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include Group discussions, Problem-solving sessions, Seminars, independent learning etc..	54	36	-	10	100
Pre-requisite	Basic understanding of natural resources					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basic concepts of Natural Resources	U	1
2	Understand and evaluate the fundamental concepts of ecosystem management	U,E	1.2
3	Apply and evaluate various strategies for water resource management	A,E	2,4
4	Analyse and evaluate the management of various physical and biological resources	An,E	1,2,4

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Natural resources** Classification on the basis of recovery rate - Renewable and Non-renewable resources; origin-biotic and biotic resources; stages of development – potential, actual, reserve & stock; National international status of non-renewable resources; Status of extraction of natural resources- global and regional	17	1

2	**Ecosystem management** Forest and Grassland management; Wetland Management; Management of Coastal and marine ecosystems; People's participation in ecosystem management	15	1, 2, 4
3	**Water resource management** Global Water Budget, global water availability, depletion of water resources, Interrelation of water resources with other natural resources and the environment; Basic Techniques for Water Analyses – Quality and Quantity; Watershed management; Irrigation water management; Integrated Water Resources Management (IWRM); Concept of sustainable water resources development; Global Efforts - water resource management, Local water organisations; World water organisations; UN, GWP, WWC, etc**.**	22	1, 2, 3
4	**Physical Resources** Soil and mineral resources- status and significance, problems facing; Soil quality management – engineering and ecological solutions; Control of soil erosion; Soil Management in Kerala; Radioactive minerals and their management; Metals and other minerals – management strategies	19	2, 3, 4
5	**Biological Resources** Forest resource management – NTFPs, biodiversity, medicinal plants; Integrated management of wildlife population; Sustainable Management of biological resources of Kerala	17	2, 3, 4

References

1. *Abbasi, S.A. (2001) Water resources projects and their environmental impacts. Discovery publishing house, New Delhi.*
2. *Gangstad, I. (1990). Natural Resource management of water and land. Van Norstrand Reinhold, New York.*
3. *Petak, W.J and Atkisson, A.A. (1982). Natural Risk Hazard Assessment and Public policy. Springer- Verlag, New York*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests, Assignments, Seminar Presentation, Review Report B. End Semester Examination (60%)
School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

Programme	**Five Year Integrated M.Sc. (Environmental Science)**		
Course Name	**Environmental Engineering**		
Type of course	**Core**	**Credit Value**	**3**
Course code	**IMSC902ES**		
Name of Faculty			
Course Summary& Justification	**Course Summary**: Application of Environmental Engineering principles in Air, Water Resources and Solid Waste Management. The course has been designed with essential components of Engineering concepts so that the science graduates can understand and appreciate the course. The last unit provides a brief insight into Industrial Risk Assessment techniques. **Justification**: As mentioned above, this course aims to train science graduates with essential inputs from (Environmental) Engineering so that a capacity building can be attained among the students to equip them to face the job market.		
Semester	**IX**		

Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include: Group discussions, Problems solving sessions, Seminars, Independant Learning etc..	36	36	-	8	80
Pre-requisite	Foundational knowledge in quantitative skills					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand air and water resource management, solid waste management through the concept of System approach. Describe the basics of mass balance analysis in Environmental Engineering.	U, R, A	4,5
2	Understand various steps and techniques of water and wastewater treatment. Apply system approach in water resource management.	U, A, E	4,5,6
3	Describe air quality standards. To understand meteorological factors in air pollution and apply theories and models in air pollution/emission dispersion.	U, A	2,4,5
4	Understand different air pollution control techniques.	U, E, I	4,6
5	Explain the importance of Solid Waste Management with the concept of a system approach. Evaluate various techniques in solid waste processing and disposal.	E, C	4,6,7
6	Understand the noise pollution concept, analyse the ambient noise level; Describe the risks associated with industries and analyse the risk using various risk analytical techniques.	U, A, An, E	4,6,7

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Introduction** Environmental Engineering and Environmental Systems: Water resource management; air resource management; Solid waste management systems; Mass-balance approach to problem solving	7	1, 2, 3
2	**Water Resource Management: Water and Wastewater Treatment** Water quality studies: Sampling technique, Sampling devices, Sample preservation, Physical – Chemical and biological examination of water , Water quality standards; Water treatment - Filter plants : Mixing and flocculation, Coagulation, Jar test; Softening – lime soda and ion exchange process ; Filtration – slow, rapid and high – rate sand filters; Disinfection – Chlorination, Ozonation and UV application; Wastewater treatment : Municipal sewage treatment - Basic treatment processes and flow- sheets, Waste flow rates and their assessment; Unit operations of pre-treatment and primary treatment - Bar racks, grit chambers, communitors, equalization and sedimentation, Design concepts; Secondary treatment: Biological unit processes - Nature and kinetics of biological growth; Aerobic activated sludge process and its various modification; Oxidation ponds; Attached growth systems – trickling filters, Rotating biological contactors (RBCs); Anaerobic wastewater treatment systems: Evolution of high – rate anaerobic reactors – CSTRs; Up flow anaerobic filters (UAFs); UASBs, Expanded / Fluidised bed reactors; Chemical unit process: Precipitation, Coagulation, Disinfection; Tertiary / Advanced treatment system: Filtration; Adsorption; Nitrogen and phosphorous removal; Biological nutrient removal (BNR) system; Land treatment – Slow rate, overland flow, rapid infiltration	16	1, 2, 3
3	**Air Resource Management: Air quality studies** Air quality standards: Micro and macro air pollution; Indoor air pollution; Acid rain; Ozone depletion; Greenhouse effect; Air quality standards: Micro and macro air pollution; Indoor air pollution; Acid rain; Ozone depletion; Greenhouse effect; Air pollution meteorology: The atmospheric engine; Turbulence, stability, laps rate, plume behavior, terrain effects; Factors affecting dispersion of air pollutants; Dispersion modeling – Gaussian dispersion mode	12	2, 3
4	**Air Resource Management: Air Pollution Control** Control of particulate matter: Gravitational; Centrifugal; Electrostatic, fabric and wet collectors; Control of gaseous contaminants: Adsorption; Absorption; Condensation; Combustion; Automobile emission control	10	3, 4
5	**Solid Waste Management: Municipal Solid Waste** Types, sources and properties; Techniques for treatment / processing of solid waste: Recovery, reclamation, recycle and reuse of resources; Disposal methods for the solid waste residues: Incineration; Sanitary	13	4,5

	landfills; Hazardous waste management		
6	**Noise Pollution and Risk Assessment** Noise pollution; Noise levels, measurements and noise limits; Noise attenuation and control measures; Risk assessment and disaster management for industries: Case histories of major chemical disasters; Basic components of hazard control system; Technique of risk assessment – PHA, HAZOP, MAXCRED; Emergency control and disaster plan	14	6

References

1. *Abbasi, S.A. and Ramasamy, E.V., 1999. Biotechnological Methods of Pollution Control Orient Longman, (Universities Press of India Ltd.) India, 168.*
2. *Agrawal, S. K. (2013). Water Pollution, APH Publisher.*
3. *Basak, N.N. 2003.Environmental Engineering. Tata McGraw –Hills Publishing Company Limited. New Delhi.*
4. *Davis, M.L. and Cornwell, D.A. 1991. Introduction to Environmental Engineering, McGraw Hill International Edition*
5. *Edzwald, J. K. (2011). Water Quality & Treatment: A Handbook on Drinking Water, McGraw-Hill Education.*
6. *Freeman, .H.M. 1998. Standard book of Hazardous Waste Treatment and Disposal, McGraw Hill, New York.*
7. *Gaur, R.C. 2008. Basic Environmental Engineering .New Age International (P) Ltd .New Delhi.*
8. *Hill, M.K. 2004. Understanding Environmental Pollution, Cambridge University Press, Cambridge, U.K.*
9. *Ismail, S.A. 2005. The Earthworm Book, Other India Press, Goa, India.*
10. *Kiely, G.1997. Environmental Engineering. Tata McGraw –Hills Publishing Company Limited. New Delhi.*
11. *Masters, G.M and Wendell, P.E.2008. Introduction to Environmental Engineering and Science. Pearson Education Inc. South Asia.*
12. *Meenakshi, P. 2005. Elements of Environmental Science and Engineering .Prentice –Hall of India Private Limited. New Delhi.*
13. *Noyes, R.2005. Unit Operations in Environmental Engineering. Jaico Publishing House. Mumbai.*
14. *Palmer, E. 2010. Water pollution, Apple Academic Press, Inc.*
15. *Peavy, H. S., Donald, R. R., Tchobanoglous, G. 2017. Environmental Engineering, New York: McGraw-Hill Education.*
16. *Rao, P.V.2002. Text Book of Environmental Engineering. PHI Learning Private Limited. New Delhi.*
17. *Reynolds, T.D and Richards .P.A.1996.Unit Operations and Processes in Environmental Engineering. PWS Publishing Company. New Delhi.*
18. *Scragg, A. 1999. Environmental Biotechnology. Addison Wesley Longman, Singapore.*
19. *Sincero, A.P and Sincero.G.A.1996. Environmental Engineering a Design Approach. Prentice –Hall of India Private Limited. New Delhi*

20. *Singh, B. S., Kumar, R., Singh, M. R. 2012. Water pollution and Environment, Enkay Publishing house.*
21. *Singh, R. 2015. Membrane technology and engineering for water purification: application, system design, and operation, Elsevier Publisher*
22. *Soggard, E. G. 2014. Chemistry of advanced environmental purification processes of water: Fundamental and application, Elsevier Publisher.*
23. *Tchobanoglaus, G., Theisen, H and Vigil, S.A. 1993. Integrated Solid Waste Management: Engineering Principles and Management issues, Mc Grew Hill International Edition, Singapore.*
24. *Weiner, R.F and Matthews R.A.2003. Environmental Engineering. Elsevier. New Delhi.*
25. *Winblad, U and Simpson-Hébert, M (editors) 2004: Ecological sanitation –revised and enlarged edition. SEI, Stockholm, Sweden.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M.Sc. (Environmental Science)**					
Course Name	**Environment Management**					
Type of course	**Core**		**Credit Value**		**3**	
Course code	**IMSC903ES**					
Name of Faculty						
Course Summary& Justification	This course is structured to allow students to grasp the core principles and ideas behind Environmental Management and sustainable development, aiming to prepare them for proficient environmental planning and management.					
Semester	**IX**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	36	-	8	80
Pre-requisite	Studentsneed to have a solid grasp of environmental science, sustainability concepts, policy frameworks, and analytical skills to assess and address environmental issues.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Understand the basic concepts of Environment Management	R, U	1
2	Understand and evaluate the fundamental concepts of ecosystem management and sustainable development	U	1,2
3	Evaluate long term mitigation measures for resource depletion	An, E	3,6
4	Explain and apply environmental planning in long term management of natural resources	U, A, S	3,6,8
5	Assess the current environmental issues	An, E	7,8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Sustainable Management** Introduction Concepts and dimension, Theories and definitions, Role of environmental Planning and management in Sustainable Development.	5	1,2
2	**Introduction Natural resources** Definition, classification, types, concepts and approaches of natural resource conservation - Natural resources of India, Natural resources degradation-types and causes, loss of biodiversity, land degradation, deforestation, ecological and social impact of resource depletion	7	1,2
3	**Soil (land) Resources Management** Distribution of Soil resources – Role of agricultural practices in soil degradation - Soil erosion – Soil fertility and nutrient management: Role of organic matter and its significance in soil quality – Diagnosis of soil nutrient deficiencies – Organic farming: Principles, benefits and methods of organic farming; Green manuring, Animal manures and composting - Wasteland development strategies.	12	3, 4
4	**Mineral Resources Management Resources and reserves** Origin, distribution and uses of economic minerals - Exploration of mineral resources from oceans - Steps in mineral exploitation, Impact of exploitation of economic minerals on environment - Conservation of economic mineral resources. Management strategies.	10	3, 4
5	**Water Resources Management Integrated water resource management** Watershed management – Rain water harvesting – Interlinking of rivers and river basin management - Wetland conservation – Coastal zone management strategies - Ecological significance of mangroves, Coral reefs and its conservation, Management strategies.	11	3, 4
6	**Forest Resources Management Significance for the conservation of forest resources** Distribution of forests, Wood production, Forest land use changes in India, Future demand of forest land, Carbon sequestration - Forest management tools: Social forestry, Agro-forestry and Urban forestry – Eco development committees, Ecotourism, Climate change reduction, Carbon trading and Management of grasslands, Management strategies.	10	3, 4
7	**Management of Biological Resources** Biological Resource for health Management- Medicinal plants, Identification of problems and development of sustainable management strategies for biological resource with particular reference to Kerala.	9	3, 4
8	**Social Issues and the Environment Management** Basic concepts of Social and human interference, management of social environmental issues and urban problems related to energy; Water conservation, rain water harvesting and watershed management; Resettlement, rehabilitation of people, its problems and concerns; Pollution impacts to environment (Climate change, global warming, acid rain, ozone depletion), nuclear accidents and holocaust, wasteland reclamation, consumerism and waste products, public awareness,	8	4, 5

	population growth and family welfare programme, human rights, women and child welfare; Role of information technology in environmental conservation and management		

References

1. *Dutta, A. (2001), Biodiversity and Ecosystem Conservation, Kalyani Publishers, Kolkata.*
2. *Jha, L. K. (1997), Natural Resource Management, APH Publishing Corporation, New Delhi.*
3. *Kumar, H. D. (1995), Modern Concepts of Ecology, Vikas Publishing House (P) Ltd., New Delhi.*
4. *Dicken, K. G. M. & Vergora, N. T. (1990), Agroforestry: Classification & Management. John Wiley & Sons, New York.*
5. *Nalini, K. S. (1993), Environmental Resources and Management, Anmol Publications (P) Ltd., New Delhi.*
6. *Nautiyal, S. & Kaul, A. K. (1999), Forest Biodiversity & its Conservation Practices in India. Oriental Enterprises, Dehra Dun, India.*
7. *Owen, O. S. & Chiras, D. D. (1995), Natural Resources Conservation, Prentice-Hall India, New Delhi.*
8. *Sarah, F. (2011), Natural Resource Management, Oriental Enterprises, Dehradun, India.*
9. *Ian, N. (2009), Agroforestry for Natural Resource Management, CSIRO publishing, Oxford.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M.Sc. (Environmental Science)**					
Course Name	**Advanced Geomatics and Applications**					
Type of course	**Core**	**Credit Value**	**3**			
Course code	**IMSC904ES**					
Name of Faculty						
Course Summary& Justification	Teaching critical spatial thinking in higher education empowers graduates to effectively engage with spatial data. Geoinformatics has wide application across many science disciplines; we evaluate how this contributes to critical spatial thinking. The discipline of GIS covers the whole process of spatial decision-making in the environment as well as disaster management. We outline how some existing GIS principles could be improved to focus on the development of critical spatial thinking skills, competencies and abilities that are valuable to graduates.					
Semester	**IX**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include Group discussions, Problem-solving sessions, Seminars, Independent Learning etc.	36	36	-	8	80
Pre-requisite	Students have a foundational background in geography, spatial analysis, and technology, enabling them to effectively comprehend and apply geospatial data and tools.					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Demonstrate the basics of mapping concepts and Geodesy	U	1,4
2	Understand the various data formats and data types in GIS	U	1,2
3	Understand the significance of various satellite based remote sensing products	U	1,2,4
4	Apply the spatial and non- spatial data using various methods	An,A	4,5
5	Appraise the importance of spatial planning in environment management.	E,Ap	2,4,5
6	Design methods to solve environmental issues based on various spatial data products	C,S,Ap	4,7,8
7	Outline and Evaluate the role of navigational satellite systems in geoinformatics.	U, E	4,5,8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Geodetical aspects, mapping concepts and surveying** Earth System – Geodesy: Datum/Spheroids and coordinate systems, map projection - different projections and their characteristics; Features on the earth's surface: their basic properties – discrete vs continuous and geometries of representation; Cartography: Maps – their characteristics and elements, types - Basic surveying principles and techniques: EDMs and GNSSs; GNSSs – segments, various constellations, errors, differential correction and precise positioning; Map reading and interpretation; Global, national and state mapping agencies and their authorized reference maps – general & thematic	11	1
2	**Remote sensing: Introduction** Remote sensing system – components and principles – platforms, sensors, medium, target, interactions and their characteristics including various resolutions, concept of DN value, radiance, reflectance, emission; Electromagnetic spectrum - energy interaction with atmosphere and earth surface, atmospheric windows, spectral properties of various objects on the earth's surface and the concept of spectral signature, active and passive remote sensing; Space borne earth observation: various orbits and their characteristics, operations, image acquisition and various data products Indian remote sensing programme& Other satellites and sensors like Landsat, SPOT, etc.	15	3
3	**Digital Image Processing** Various image formats, loading and visualization – panchromatic and multispectral colour visualization – TCC and FCCs; Image restoration – geometric, radiometric – atmospheric errors and their correction; Image enhancements – single band, multiband operations – layer stacking, rationing and various indices, PCT, TCT, resolution merging/image fusion; Image interpretation – visual and digital; visual interpretation elements and key; Digital image classification – unsupervised and supervised; accuracy assessment	13	3,5,6
4	**Geographical Information System (GIS): Basics** Concepts, components and organisation of GIS; Representing &modelling spatial features and processes - vector and raster structures, relationship between features – topology; raster data compressions and storage formats; Non-spatial/attribute Database Management Systems (DBMS), significance of DBMS, principles, data types, models – RDBMS, data storage, query and retrieval; Basic GIS functions: data inputting methods & various data sources, data management, data manipulation and geographic analysis and output presentation	10	2,4
5	**Global Navigational Satellite Systems: Basics** Basic Global Navigational Satellite Systems (GNSSs) concepts: History and timeline, overview. Components of GNSSs (Space Segment, Control	9	4,5,7

	Segment, User Segment),GPS working principle; GPS (Global Positioning System), - GLONASS, Galileo,BeiDou, NavIC, GPS signals (L1 and L2 Frequencies)/ CourseAcquisition (C/A) code Precision (P) code		
6	**Geographic analysis and modelling** Exploration, query, vector spatial analysis & geoprocessing – extraction, proximity, overlay; Network analysis – route, trace, closest facility, allocation; Raster based spatial modelling and analysis – density, distance, map algebra – arithmetic & weighted overlay: multi-criteria decision making; Surface modeling and analysis: DEM creation – input sources, interpolation; slope, aspect, volume, profile, hill shade, view shed, visibility, contouring	14	2, 3,5,6

References

1. *Agarwal S. K. 2002. Eco- informatics. APH Publishing Corporation, 1535 pages, ISBN- 13: 978- 8176483247.*
2. *Agarwal N. K. 2004. Essentials of GPS. Spatial Networks Pvt. Ltd., Hyderabad*
3. *Anji Reddy M. 2004.Geoinformatics for Environmental Management. B. S. Publications*
4. *Burrough P.A. and McDonnel A. R. 1998.Principles of Geographic information Systems. Spatial information systems and Geostatistics. Oxford university press.*
5. *Chouhan T. S. and Joshi K. N. 1996.Applied remote sensing and photo interpolation. Vigyan Prakasham, Jodhpur.*
6. *Coronel C., Morris S. and Rob P. 2009. Database Systems: Design, Implementation and Management (9th Ed.). Course Technology, 700 pages, ISBN- 13: 978- 0538748841.*
7. *David L. Verbyla. 1995. Satellite Remote Sensing of Natural resources. Lewis Publishers, New York*
8. *George Joseph. 2005. Fundamentals of remote sensing (Second Edition). Universities Press (India) Pvt. Ltd., Hyderabad.*
9. *Goodchild M. F., Parks B. O. and Steyaert L. T. (Eds.). 1993. Environmental Modeling with GIS (Spatial Information Systems). Oxford University Press, USA, 520 pages, ISBN- 13: 978- 0195080070*
10. *Heywood I., Cornelius S., Crever Steve. 2003. An Introduction to Geographical Information Systems. Pearson Education.*
11. *Jensen J. R. 2000. Remote Sensing of the Environment - An Earth Resources Perspective, Pearson Education, Inc. (Singapore) Pvt. Ltd., Indian edition, Delhi.*
12. *Jensen J. R. 1996. Introductory Digital Image Processing. Prentice Hall Series.*
13. *John Wainwright and Mark Mulligan (Eds). 2004. Environmental modeling - finding simplicity in complexity. John Wiley & Sons Ltd.*
14. *Jorgensen S. E., Chon T. S. and Recknage F. A., 2009. Handbook of Ecological Modeling and Informatics. WIT Press, 448 pages, ISBN- 13: 978- 1845642075.*
15. *Kang-tsung Chung. 2002. Introduction to Geographical Information System. McGraw Hill Companies, International edition.*
16. *Lillesand T. M., Kiefer R. W. and Chipman J. W. 2008.Remote Sensing and Image Interpretation (Sixth Edition). John Wiley & Sons, USA*
17. *Maguire D., Batty M. and Goodchild M. (Eds.) 2005.GIS, Spatial Analysis, and Modeling. Esri*

Press, 496 pages, ISBN- 13: 978- 1589481305.

18. *Peng Z. P.andTsou M.H. 2003. Internet GIS: Distributed Geographic Information Services for the Internet and Wireless Networks. Wiley, Hoboken, NJ.*
19. *Rafael C. Gonzalea and Richard E. Woods. 2004. Digital Image Processing (2nd). Pearson education.*
20. *Sabins Floyd F. 1987.Remote Sensing principles and interpretation (3rd). W. H. Freeman and Company, New York.*
21. *Shan J and Toth C. K. 2008.Topographic laser ranging and scanning - principles and processing. CRC Press, Taylor & Francis Group, London.*
22. *Skidmore A. 2002. Environmental modeling with GIS and Remote Sensing. Taylor and Francis.*
23. *Steven E. Franklin. 2001. Remote Sensing for Sustainable forest management. Lewis publishers*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**Five Year Integrated M.Sc. (Environmental Science)**					
Course Name	**Environmental Impact Assessment**					
Type of course	**Core**		**Credit Value**		**2**	
Course code	**IMSC905ES**					
Name of Faculty						
Course Summary& Justification	The course is designed to teach students about Environmental Impact Assessment (ElA) and how it applies to various sorts of development projects. Students will be familiar with the standard procedure for conducting EIA studies for various governmental and non-governmental organisations. The course will also help students to understand and carry out the environmental auditing and life cycle assessment.					
Semester	**IX**					
Total Student Learning Time (SLT)	Learning Approach	Lecture	Tutorial	Practical	Others	Total Learning Hours
	Others include Group discussions, Problem-solving sessions, Seminars, Independent Learning etc..	36	18	-	6	60
Pre-requisite	Basic understanding of environmental science, ecological principles, and regulatory frameworks					

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Describe the global changes and sustainability	U	2,3
2	Explain the EIA process, LCA, and Environmental audit	R,U	4,5
3	Explain the role of various agencies in EIA	U, An	5,6
4	Assess the project impacts and role of public participation in EIA	E	5,6,7
5	Do EIA using various methodologies	A,An	7,8
6	Do Environmental Audit	A,An,E	7,8
7	Explain the LCA and EMS	U	2,4

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Module	Course Description	Hrs.	CO No.
1	**Development projects and sustainability** Developmental Projects – types and proponents; Global changes and concept of Sustainability; Factors affecting sustainability; Efforts in achieving sustainability; Environment Management Techniques for Sustainable Development	5	1
2	**Environmental Impact Assessment** Definition, aim, history, principles and concepts and scope; EIA steps; Types of EIA; Public participation in EIA- significance; EIA – history and notifications in India; EIA in India – organizational structure	6	2, 3
3	**Environmental Impacts** Positive and negative impacts Primary and Secondary impacts Impact on physical, social and biotic environments; Baseline evaluation; Alternatives and mitigation measures in EIA; Terms of reference	9	2, 4
4	**Environmental Impact Assessment methods** EIA Methods and their functions; Adhoc method, Checklist Method, Sectoral guidelines, Systematic sequential approach, Simulation modelling workshops, Spatial analysis methods, Rapid assessment techniques; Interaction Matrices- Network and Overlays Approach, Moore Impact matrix	10	4, 5
5	**EIA for different environmental programmes** EIA for Industries, Urban development, mining; Energy projects: Hydel, Thermal, Nuclear, Oil and gas, Solar, Wind; EIA case studies	8	2,4,5
6	**Environment Audit** Introduction to environment audit-types; Environment auditorauditing skills; Environment audit procedure – pre audit, site visit and post audit; Environmental auditing standards	7	2,6
7	**Life Cycle Assessment (LCA) and EMS** LCA – introduction, basics, objectives Life cycle stages, LCA components Global and regional impact categories LCA applications – case studies LCA and standards; Environment Management System (EMS)- introduction, structure, Procedure; LCA and EMS - Case studies	9	2,7

References

1. *Cauter, I.M. (1981) Environmental Impact Analysis. Mc Graw Book Co. New York.*
2. *Glasson, J., Therivel, R and Chadwick, A. (1994). Introduction to Environmental Impact Assessment. UCI Press Ltd. London*
3. *Khadka, R .Bet al. (1996). EIA- Training Manual for professionals and managers. Asian Regional Environmental Assessment Programme- IUCN Nepal.*
4. *Lohani, B.N, Envas, J.W, Evertt, R.R, Ludwig, H, Carpenter R.A, Shih Liang Ta. (1997). Environmental Impact Assesment for Developing Countries in Asia. Vol 1 & Vol 2. Asian Developmental Bank.*
5. *Morris, P and Therivel, R. (1995). Methods of Environmental Impact Assessment, Press ltd, London.*
6. *Shukla S.A and Shrivastava, P.R. (1992).Methodology and environmental monitoring and*

assessment. Common wealth Publishers, New Delhi.

7. *Wathem, P. (Ed) (1986). Environmental Impact Assessment. Theory and Practice. 8. Westman*

8. *W.E. (1985). Ecology, Impact Assessment and Environmental Planning. John Weily Pub, New York*
9. *Westman W.E. (1985). Ecology, Impact Assessment and Environmental Planning. John Weily Pub, New York.*

Teaching and Learning Approach	**Class room Procedure (mode of transaction)** • Direct Instruction: Lecture, Explicit Teaching, E-learning • Interactive Instruction: Active co-operative learning, Seminar, Group Assignments, Peer teaching and learning, Technology-enabled learning, Library work
Assessment Types	**Mode of Assessment** A. Continuous Internal Assessment (40%) Internal Tests Assignments Seminar Presentation Review Report B. End Semester Examination (60%)

SchoolName	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**					
Programme	**FiveYearIntegratedM.Sc.(EnvironmentalScience)**					
CourseName	**Seminar- Current issues & trends in Environmental Science**					
Typeof course	**Elective**	**CreditValue**	**1**			
Coursecode	**IMSE907ES**					
NameofFaculty						
CourseSummary &Justification	In this course, students will explore significant problems and creative solutions by looking at current environmental concerns and the latest progress in environmental science. Seminars, discussions, and case studies will be used to help students comprehend the same					
Semester	**IX**					
Total StudentLearningTime(SLT)	LearningApproach	Lecture	Tutorial	Practical	Others	TotalLearningHours
	Library work, Independent learning, Literature review, Seminar	-	36	-	-	36
Pre-requisite	Subject knowledge, communication, and presentation skills					

COURSEOUTCOMES(CO)

CONo.	ExpectedCourseOutcome	Learning domain	PSO No
1	Understand the present-day environmental concerns across the globe	U	1,2
2	Able to understand the scientific research and developments related to environmental science	A	5
3	Assist in the creation of novel research approaches and identify gap areas for future research	A, E	5,8
4	Exposure to journals and other publications in the field of environmental science	An,E	6,7,8
5	To understand the social, economic, and political dimensions of environmental challenges.	An, E,I	6,7

**Remember(R), Understand(U),Apply(A),Analyse(An),Evaluate(E),Create(C),Skill(S),Interest (I)and Appreciation(Ap)*

Teaching and LearningApproach	**ClassroomProcedure(modeof transaction)** • DirectInstruction: Lecture,ExplicitTeaching,E-learning • Interactive Instruction: Active co-operative learning, Seminar,Demonstration, Peer teaching and learning, Technology-enabledlearning,Librarywork,
AssessmentTypes	**Modeof Assessment** A. Evaluation of the presentation by both internal and external examiners B. 30 minutes presentation (100%)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Environmental Science)**		
Course Name	**Major Research Project**		
Type of course	**Core**	**Credit Value**	**16**
Course code	**IMSC100PR**		
Name of Faculty			
Course Summary& Justification	As part of this course student is expected to carry out an Internship/ project work under the guidance of a research supervisor, in a reputed research/academic Institution. This course will provide extensive training on methods and methodology of research in the area of study. Accordingly, the student shall acquire updated knowledge, skill and training on the area of research. At the end of this coursestudent has to submit a detailed project report andpresent a seminar. It will be evaluated by the Examination Board consisting of both Internal and External Examiners.		
Semester	**X**		
Total Student Learning Time (SLT)	Total Learning Time		
	Five months		
Pre-requisite	Theoretical knowledge in Environmental Science and Basic laboratory skills		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Acquire sufficient Knowledge, training and skills to undertake independent, original and critical research on a relevant topic.	U, A, S, E, C	1-8
2	Gain expertise in Scientific literature survey and academic writing and develop interest for further research	S, I, AP	3,6,7,8
3	Skills to effectively present the objectives, methodology, analysis, and results of the research study.	S	1,5,8
4	Familiarize with advanced and modern research topics/trends	U, Ap	4,5,6
5	Capability to plan and use adequate methods to conduct specific tasks in given frameworks	A,An	1-8
6	Gain a consciousness of the ethical aspects of research	U, An	2,6,7
7	Create, analyze and critically evaluate different problems and their solutions	An, E, C	1-8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

COURSE CONTENT

Course Description	Months	CO No.
Student shall carry out a 5 to 6 months of Research Project in a relevant area related to Environmental scienceand submit the project report/dissertation at the end of the course.	5-6	1-7

Laboratory Procedure (mode of transaction)

- Direct Instruction: Explicit Teaching, Demonstration, Hands onexperimental sections, Skill acquisition by laboratory training, Journal Club

Mode of Assessment

- Evaluation of the Project by the Examination Board consisting of the Chairman, both Internal and External Examiners based on the quality and quantity of the project work done, Report, and 30 minutes presentation at the End of the Semester (100 %)

	IIRBS, MAHATMA GANDHI UNIVERSITY
	Five Year Integrated Master of Science (Environmental Science)

School Name	**Institute for Integrated programmes and Research in Basic Sciences (IIRBS)**		
Programme	**Five Year Integrated M.Sc. (Environmental Science)**		
Course Name	**Comprehensive Viva Voce**		
Type of course	**Core**	**Credit Value**	**4**
Course code	**IMSC100VV**		
Name of Faculty			
Course Summary& Justification	The comprehensive viva-voce shall be conducted by the Examination Board consisting of the Chairman, Internal Examiner and External Examiner. A thorough understanding of all the M.Sc. level course contents and recent trends in the broad area of Environmental Science areevaluated.		
Semester	**X**		
Total Student Learning Time (SLT)	Total Learning Time		
	-		
Pre-requisite	Basics as well as in-depth knowledge in the courses he/she have studied		

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning domain	PSO No
1	Reproduce acquired knowledge/ understanding about the subject of study	R, U, A	1-8
2	Acquire more in-depth knowledge of the major subject of study and apply this knowledge in diverse contexts.	U, A, I	1-7
3	Develop problem solving ability by promptly analyzing /evaluating a problem	An, E, S	2,4,5
4	Increase communication skill and confidence of students by question answering and discussion.	S, I, Ap	5,7
5	Able to contribute to research and development work	I	8

**Remember (R), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

Assessment Types	**Mode of Assessment** • A thorough understanding of all the M.Sc. level course contents and recent trends in the broad area of Environmental sciences are evaluated through questions and discussions by the board of examiners at the End of the Semester (100%)