PT. RAVISHANKAR SHUKLA UNIVERSITY

RAIPUR - 492 010, CHHATTISGARH

CURRICULUM & SYLLABI
(Based on CBCS & LOCF)

M.Sc. Environmental Science
Semester System

Session: 2024-25 & onwards

Approved by:	Board of Studies	Academic Council
Date:		

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Online	Online
	Prof. P. K. Behera (External member									Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. ENVIRONMENTAL SCIENCE COURSES

The Environmental Science is a multidisciplinary subject includes chemistry, physics, geology, geography & biology. The teaching and research in the environmental science is urgently required for understanding and controlling the complex environmental issues arising at the local, regional and global scales. It is the science of physical phenomena in the environment. It studies of the sources, reactions, transport, effect and fate of chemical and biological species in the air, water and soil, and their effect on human activities.

Program Outcome

Upon successful completion of the Master of Science in Environmental Science program, students will be able to:

PO-1	**Knowledge:** Demonstrate a deep understanding of advanced Environmental concepts, theories, and techniques in various subfields of Environmental Science. Will develop basic understanding about the subject and become aware of the progression made in realm of Environmental Science.
PO-2	**Critical Thinking and Reasoning:** Exhibit advanced critical thinking skills by analyzing and evaluating Environmental Science arguments, theories, and proofs, and by making reasoned judgments about Environmental Science concepts and their implications. Will have knowledge about importance and applications of the Environmental Science in the day to day and betterment of society.
PO-3	**Problem Solving:** Formulate abstract Environmental problems and derive solutions using rigorous logical reasoning. Demonstrate mastery in constructing Environmental Science proofs and justifications. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems. Acquired the knowledge and skills needed for the environmental design and management.
PO-4	**Advanced Analytical and Computational Skills:** Possess advanced skills in Environmental data analysis and computation, including proficiency in using acquired skills in the preparation, planning and implementation of environmental projects.
PO-5	**Effective Communication**: Communicate complex Environmental ideas and results effectively to both technical and non-technical audiences, through written reports, presentations, and teaching. Environmental human communication is constitutive because it helps shape human understanding of environmental issues, themselves, and nature. Examples include values, attitudes, and ideologies regarding nature and environmental issues.
PO-6	**Social/ Interdisciplinary Interaction**: Integrate Environmental concepts and techniques into interdisciplinary contexts, collaborating effectively with professionals from other fields to address complex problems.

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
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PO-7	**Self-directed and Life-long Learning**: Recognize the importance of ongoing professional development and lifelong learning in the rapidly evolving field of Environment, and will exhibit the ability to continue learning independently or in formal educational settings. Evaluate all the environmental factors considering with at all points such as technical, social, legal and economical aspect.
PO-8	**Effective Citizenship**: **Leadership and Innovation:** Lead and innovate in various Environmental contexts, contributing to advancements in the field and applying Environmental insights to emerging challenges. Basic understanding regarding this subject may possibly help them to opt environmental science, biodiversity, climate change, Environmental Impact Assessment etc., as a profession for their livelihood.
PO-9	**Ethics**: Demonstrate ethical and responsible conduct in research, teaching, and collaboration, adhering to professional standards and best practices. Encourages students to become more aware of the impacts they have on the environment and fosters an understanding of our planet.
PO-10	**Further Education or Employment:** Engage for further academic pursuits, including Ph.D. programs in environment or related fields. Get employment in academia, research institutions, industry, government, and other sectors.
PO-11	**Global Perspective**: Recognize the global nature of Environmental research and its impact, appreciating diverse cultural perspectives in Environmental practices.

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PROGRAMME SPECIFIC OUTCOME (PSOs): At the end of the program the student will be able to:

PSO1	Understand the nature of abstract Environmental Science and explore the concepts in further details. Graduate has gained thorough understanding of Environmental Science as collated in the curriculum and developed the capability of self-learning to continue the search for knowledge
PSO2	Apply the knowledge of Environmental Science concepts in interdisciplinary fields and draw the inferences by finding appropriate solutions. Graduate has gained skills to apply the knowledge to the environmental challenges before the society of the nature of local, regional, or global dimensions aligned with the economy and sustainability.
PSO3	Graduate has gained research acumen and developed critical thinking to carry out research in the domain, and continue learning. Pursue research in challenging areas of pure/applied Environmental Science field.
PSO4	Employ confidently the knowledge of Environmental Science software such as Remote Sensing and GIS and tools for treating the complex Environmental problems related to Air, Water, Soil, Noise etc. and scientific investigations. Graduate has acquired the sense of responsibility to safeguard the environment as a constitutional duty.
PSO5	Effectively communicate and explore ideas of Environmental Science for propagation of knowledge and popularization of Environmental Science in society. Qualify national level tests like NET/SET/GATE etc.

M.Sc. ENVIRONMENTAL SCIENCE

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	22	95
Elective	II	02	05
Total		24	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	02
Skill Enhancement (Value Added Courses)	I, III	02	02

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M.Sc. Environmental Science

STRUCTURE OF THE SYLLABUS

Course Code	Course Nature	Course Tile	Credits	Hrs /Week	T/P	Evaluation Total		
A	B	C	D		E	CIA	ESE	TOTAL
Semester-I (YEAR I)								
ENV101	CORE	Fundamental of Ecology	**5**	**5**	**T**	**25**	**75**	**100**
ENV102	CORE	Renewable, Non-renewable and Perpetual Resources	**5**	**5**	**T**	**25**	**75**	**100**
ENV103	CORE	Solid & Hazardous Waste Management	**5**	**5**	**T**	**25**	**75**	**100**
ENV104	CORE	Instrumental Techniques & Analytical methods in Environmental Science	**5**	**5**	**T**	**25**	**75**	**100**
ENV105	CORE	Lab work-1	**3**	**10**	**P**	**25**	**75**	**100**
ENV106	CORE	Lab work-2	**2**	**10**	**P**	**25**	**75**	**100**
Semester-II (YEAR I)								
ENV201	CORE	Environmental Pollution and Control: Air and Water	**5**	**5**	**T**	**25**	**75**	**100**
ENV202	CORE	Meteorology and Climatology	**5**	**5**	**T**	**25**	**75**	**100**
ENV203	CORE	Environmental Geoscience	**5**	**5**	**T**	**25**	**75**	**100**
ENV204	FIRST ELECTIVE Subject Elective (Select any one)	Water and Wastewater Treatment Technologies	**5**	**5**	**T**	**25**	**75**	**100**
ENV205		Environmental Pollution and Control: Soil, Radiation and Noise	**5**	**5**	**T**	**25**	**75**	**100**
ENV206	CORE	Lab work-3	**2**	**10**	**P**	**25**	**75**	**100**
ENV207	CORE	Lab work-4	**2**	**10**	**P**	**25**	**75**	**100**
Semester-III (YEAR II)								
ENV301	CORE	Environmental Toxicology	**5**	**5**	**T**	**25**	**75**	**100**
ENV302	CORE	Environmental Microbiology	**5**	**5**	**T**	**25**	**75**	**100**
ENV303	CORE	Data Analysis in Environmental Science	**5**	**5**	**T**	**25**	**75**	**100**
ENV304	CORE	Environmental Biotechnology	**5**	**5**	**T**	**25**	**75**	**100**
ENV305**	CORE	Lab work-5 + Internship** (60 hours)	**2+1***	**10**	**P**	**25**	**75**	**100**
ENV306**	CORE	Lab work-6 + Internship ** (60 hours)	**2+1***	**10**	**P**	**25**	**75**	**100**
Semester-IV (YEAR II)								
ENV401	CORE	Environmental Impact assessment, Environmental Audit and Environmental Management System Standards (EIA, EA and EMSS)	**5**	**5**	**T**	**25**	**75**	**100**

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ENV402	CORE	Environmental Law, Policies and Society	**5**	**5**	**T**	**25**	**75**	**100**
ENV403	CORE	Remote Sensing and GIS	**5**	**5**	**T**	**25**	**75**	**100**
ENV404	CORE	Environmental Disaster and Risk	**5**	**5**	**T**	**25**	**75**	**100**
ENV405	RESEARCH PROJECT/ DISSERTATION	Research Project/Dissertation	**5**	**10**	**P**	**50**	**50**	**100**

**** Student should select only one course for Internship (either in ENV305 or ENV306) for 60 hrs duration**

Note:

1. In place of Elective Course Student can choose paper(s) from MOOC Courses (Swayam Portal) subject to the following conditions:
   a. The chosen paper will be other than the papers offered in the current course structure.
   b. The paper will be PG level with a minimum of 12 weeks' duration.
   c. The list of courses on SWAYAM keeps changing, the departmental committee will finalize the list of MOOC courses for each semester.
   d. The paper (s) may be chosen from Swayam Portal on the recommendation of Head of the Department.
2. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Generic Elective Courses (only qualifying in nature) offered by other departments/SoS in Semester II and Semester III.
3. The candidates who have joined the PG Programme in School of Studies (University Teaching Department), shall undergo Skill Enhancement Course/Value Added Course (only qualifying in nature) in Semester I and Semester II.

Generic Elective Courses: (Offered to PG students of other Departments/SoS only)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
II	ENV501	Research Methodology and Scientific Report for Environmental Science	T	2	2	25	75	100
III	ENV502	Environmental Toxicology	T	2	2	25	75	100

Skill Enhancement/Value Added Courses: (Offered to the PG students of SoS in Environmental Science)

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credits	Marks		
						CIA	ESE	Total
I	ENV601	Agro-Forestry and Forest Management	T	2	2	25	75	100
III	ENV602	Indian Knowledge System	T	2	2	25	75	100

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Programme Articulation Matrix:

Following matrix depicts the correlation between all the courses of the programme and Programme Outcomes

Course Code	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
ENV101	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV102	√	√	√	√	√	√	√	√	×	√	√	√	√	√	√	√
ENV103	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√	√
ENV104	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV105	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV106	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV201	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV202	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV203	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV204	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV205	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV206	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
ENV207	×	√	×	√	√	√	√	√	√	×	√	√	√	√	√	√
ENV301	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
ENV302	√	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√
ENV303	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV304	√	√	√	×	√	√	√	√	√	√	√	√	√	√	×	√
ENV305	√	√	√	√	√	√	√	√	√	√	√	√	√	×	√	√
ENV306	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√
ENV401	√	√	√	×	√	√	√	√	√	√	√	√	√	√	√	√
ENV402	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV403	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV404	×	√	×	√	√	√	√	√	√	√	√	√	√	√	√	√
ENV405	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
No. of courses mapping the PO/PSO	22	24	23	22	23	24	24	23	22	24	24	24	23	23	20	24

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Online

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M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I
Course Code	Course Title		Course Type
ENV101	**FUNDAMENTALS OF ECOLOGY**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of ecology and environment, and empower them to apply this knowledge to solve environmental problems and learn functional characteristics of ecosystems.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the concept of Ecology and Environment. Explore the component parts of an ecosystem. Explain Bio-geo-chemical cycles: Carbon cycle, nitrogen cycle, sulfur cycle, phosphorous cycle and the Functional attributes of an Ecosystem.	U
2	Concept of Primary and Secondary production. Learners will be expected to learn the basic concepts of Enthalpy and Entropy, Energy flow in producers and consumers, Lindeman's Trophic-Dynamic concept, Ecological Efficiency and Energy Flow Model.	An
3	Understand the Population Attributes, Population Fluctuation and Population Interaction. Family planning method of birth control, Socio-economic methods of controlling human population growth	Ap
4	Understand the concept of Habitat and Niche, Community Organization, qualitative and quantitative attributes of Community. Understanding the Ecotone and Edge Effect, Ecological Succession and kind of Succession.	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

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	Online									Online	Online

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	2	3	2	3	2	3	3	3	3	3	3	2	3
CO2	3	3	2	1	2	2	3	3	3	3	3	3	2	2	2	3
CO3	3	3	3	1	3	2	2	2	2	3	3	3	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3	2	2	3	2	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Concept of Ecology** History and scope of ecology: autecology, synecology, population, community, ecosystem, biome, tolerance range and limiting factors; Component parts of an ecosystem; Classification of ecosystems; Ecological factors: temperature, light, water; Bio-geo-chemical cycles: Carbon cycle, nitrogen cycle, sulfur cycle, phosphorous cycle; Functional attributes of an Ecosystem :Biological diversity and stability; Biodiversity: Index of diversity and dominance, Biological indices, relationship between species diversity, dominance and stability; Food chain: Trophic levels & ecological pyramid concept; Types of food chain & significance of food chains, pyramid of number, biomass & energy.	20	1
II	**Primary and Secondary Production and Ecosystem Energy Flow** Concept of Primary Production; Factors affecting primary production; Method for measuring primary production; Relationship between GPP & NPP, atmospheric respiration, primary productivity of different world sites; Secondary production: concept of secondary production and secondary productivity, maintenance cost, production-assimilation efficiency and secondary productivity; Relationship of secondary production to net primary production, Energy flow in Ecosystems, Concept of Energy, Energy source in Ecosystem, Laws governing energy transformation, concept of free energy, Enthalpy and Entropy, Energy flow in producers and consumers, Lindeman's Trophic-Dynamic concept, Ecological efficiencies, Energy flow models.	19	2
III	**Population Attributes, Population Fluctuation and Population Interaction** Biotic potential and natality, mortality, survivorship curves, life table, age structure, population growth forms, concept of carrying capacity and environmental resistance; Life history strategies, r and k selection, extrinsic	20	3

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	and intrinsic abiotic, biotic, density dependent and independent factors associated with population fluctuation; Population interaction like symbiosis, commensalism, parasitism, predation, competition etc.; Models for single and interacting population, social behavior in animals. Factors affecting change in size of human population: death rate and net population change, migration, fertility, age structure, Human population control; economic development and demography transition, family planning method of birth control, socio-economic methods of controlling human population growth.		
IV	**Biotic Community and Ecological Succession** Concept of habitat and niche, types of niches: spatial, trophic and hyper volume niche; ecological equivalents, community organization, types of communities, community structure (analytical and synthetic), qualitative features of community (Composition, stratification, Physiognomy, dispersion, sociability, vitality, etc.), quantitative characteristics of community (frequency, density, cover dominance and diversity, important value index), Ecotone and edge effect. Ecological succession and kind of succession, succession process, concept of climax, monoclimax, and polyclimax theories, examples of succession (hydrosere, lithosere and xerosere) and vegetation of India. Theories behind Cave Adaptations of Animals, Cave Organisms identified from Chhattisgarh and their notable troglomorphism, Energy sources in caves, Prey-predator relationship in the cave, Role of bats inside and outside the caves.	16	4

Book & References

1. E. P. Odum, Fundamental of ecology**,** W.B Sounders, 1971.
2. M. Dash and S. Dash, Fundamentals of ecology, Mc Graw Hill Education, India, 2009.
3. R. T. Wright and B. J. Nebel, Environmental science: Toward A sustainable future, Prentice Hall, 2002.
4. P. Stiling, Ecology: Theories and Applications, Prentice Hall, 2001.
5. C. Faurie, Ecology: Science and Practice, Oxford & IBH, 2001.
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8. E. J. Kormondy, Concepts of ecology, Prentice Hall, 1996.
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10. E. Odum and G. W. Barrett, Fundamentals of Ecology, Brooks Cole, 2004
11. J. B. Fraleigh, *A first course in Algebra*, Narosa,1982.

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M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I
Course Code	Course Title		Course Type
ENV102	**RENEWABLE, NON-RENEWABLE AND PERPETUAL RESOURCES (I)**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of various energy resources (both renewable and non-renewable) and its responsible uses, harnessing technologies and future aspects of energy resources also another aim of these course is to explain students about the importance of wild flora and fauna and biodiversity conservation.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Forest- importance, forest cover loss with world and Indian context, management of forest, social, agro and extension forestry, Biodiversity- definition, types, distribution and importance of biodiversity, Biodiversity hot-spot and conservation of biodiversity.	U
2	Understanding and Critical thinking about endangered species of world flora and fauna, IUCN and its importance, importance of biodiversity and its future approach.	An
3	Fossil fuels: Classification, Coal, its type and its analysis, Carbonization Oil: fractionation, cracking Octane and octane number, addition of TEL. Environmental Impact of Fossil Fuel use.	Ap
4	Understanding the concept of Geothermal hydro solar wind bio mass and Nuclear Energy and its importance and developing critical thinking about energy conservation and responsible use.	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

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Online										Online	Online

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	2	-	1	1	3	1	3	3	3	3	2	3	2	3
CO2	3	3	2	1	1	1	3	1	3	3	3	3	2	2	2	3
CO3	3	3	3	1	1	1	3	2	3	2	3	3	3	1	3	3
CO4	3	3	2	1	1	2	3	2	3	2	3	3	2	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Renewable Resources (forest)** Importance of Forest with reference to major and minor produce, climate, soil erosion, pollution control and water management, Loss of forest cover with reference to world and Indian Context, Impact of deforestation and shifting cultivation on forest ecosystems, Management of forests involving different silvicultural principles and practices. Raising forest cover through social forestry, agroforestry and extension forestry, Eucalyptus dilemma ,Joint Forest management ,People's participation and role of NGOs, Concept of Biosphere Reserve , Biodiversity and forest : definition and type of biodiversity, global distribution of biodiversity, mega biodiversity countries, key stone species, dominant species, biodiversity hot spots, significance of biodiversity, factors influencing biodiversity loss, biodiversity conservation (in situ and ex situ).	20	1
II	**Renewable Resources (Rangeland and Wildlife)** Rangeland: Importance and extent of rangeland, causes of rangeland loss, conservation and management of rangeland, Wild Life resources: Wild life & its importance. Human activities and Wild Life, Concept of Endangered Species, IUCN classification and Red data Book, ecological basis of wild Life conservation and management, some case studies on crocodile, sea turtle and project tiger. Major threats to cave biodiversity and cave assets, Major measures to be taken before and after converting a wild cave to a show cave, Tourism Versus Conservation.	18	2
III	**Non-renewable Mineral and Fossil Fuel Resources** Mineral Resources: Economic mineral deposits, grouping of ores minerals, various steps involved in extraction processes of pure metals, uses of common metals and their recycling, Radioactive minerals, Environmental impact of	18	3

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

	mining and processing mineral resources, conservation of mineral resources. Fossil fuels: Classification, Coal, its type and its analysis, Carbonization, oil: fractionation, cracking Octane and octane number, addition of TEL; natural gas and other gaseous fuels derived from fossil fuels, Environmental Impact of Fossil Fuel use.		
IV	**Perpetual & Nonrenewable and Perpetual and Renewable Energy Source** Geothermal energy: Source, Principle of harnessing energy and its operation. Nuclear Energy: Source, fission and fusion reactions, broad idea of nuclear reactor, its operations, management and electrical power generation, safety measures. Solar energy: its secret, devices based on solar energy, their advantages and drawbacks, wind energy: wind mills and applications, aero-generators, their advantages and disadvantages, Water energy: Hydroelectricity, wave and tidal energy, tidal power plant, their advantages and drawbacks Energy from biomass: Biomass as fuel, Biogas plants and generation, uses of biogas.	19	4

Reference Books:

1. F. Ramade, Ecology of natural resources, John Wiley & Sons, 1984.
2. R. Toossi, Energy and the Environment: Sources, Technologies, and Impacts, VerVe Publishers, 2008.
3. K. Singh, Handbook of Environment, Forest and Wildlife Protection Laws in India, Natraj, 1998.
4. S. S. Negi, India's Forests, Forestry and Wildlife, India Book House, 2006.
5. C. A. Simon, Alternative Energy: Political, Economic, and Social Feasibility, Rowman & Littlefield, Lanham, Maryland, 2006.
6. O. Edenhofer, Renewable Energy Sources and Climate Change Mitigation, Cambridge University Press, 2011.
7. A.Karen, Environmental Science: Understanding Our Earth, Cengage Learning, 2011
8. L. R. Berg and M. C. Hager, Visualizing Environmental Science, Second Edition, Wiley and National Geographic, 2009.
9. B. Judy and St. A. Sara, Environmental Science, Pearson – AGS Globe, 2007.

10/05/24	**Online**				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I
Course Code	Course Title		Course Type
ENV103	**SOLID & HAZARDOUS WASTE MANAGEMENT (I)**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of municipal solid waste, hazardous and radioactive waste its origin classification effects on living organisms (including flora and fauna) and develop critical thinking of how to overcome from the same.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding about solid waste and its various types with reference to their impact on environmental and human health.	U
2	Understanding and Critical thinking about utilization of solid waste with reference of energy and resource recovery through various technologies like composting and vermicomposting etc. overall solid waste management techniques are completed.	An
3	Understand various hazardous waste collection segregation and management techniques and analysis of the efficiency of hazardous waste management techniques HWM rules and regulation.	Ap
4	Understand the Classification, collection, segregation Treatment and disposal of radioactive, bio medical and e waste and its management. 5R concept of e waste. And its harmful effects on environment.	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	1	3	3	3	3	3	3	1	3	2	3
CO2	3	3	3	1	1	1	3	3	3	3	3	3	2	3	2	3
CO3	3	3	3	1	1	1	3	3	3	3	3	3	2	3	2	3
CO4	3	3	3	1	1	1	3	3	3	3	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Solid Waste** Definition of solid wastes – types of solid wastes – Sources - Industrial, mining, agricultural, municipal solid waste, Construction demolition waste, E-waste and Biomedical waste. Solid waste Problems - impact on environmental health	18	1
II	**Functional Elements of Solid Waste Management** Handling and segregation of wastes at source. Collection and storage of municipal solid wastes; analysis of Collection systems. Transfer stations. Solid waste processing technologies: Mechanical and thermal volume reduction, Biological and chemical techniques for energy and other resource recovery, composting, vermicomposting, fermentation. Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill remediation. Regulatory aspects of municipal solid waste management, Plastic waste management.	20	2
III	**Hazardous Waste and Management** Hazardous waste definition. Physical and biological routes of transport of hazardous substances – sources and characterization. Sampling and analysis of hazardous wastes –proximate analysis – survey analysis – directed analysis - handling, collection, storage and transport. Hazardous waste treatment technologies: Physical, chemical and thermal treatment of hazardous waste: solidification, chemical fixation, encapsulation, pyrolysis and incineration. Hazardous waste landfills - Site selections, design and operation. HW	19	3

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

	reduction, recycling and reuse fly ash bricks, Regulatory aspects of HWM/HWM rules.		
IV	**Biomedical, Radioactive and E-Waste Management** Classification, collection, segregation Treatment and disposal. Radioactive waste: Definition, Low level and high level radioactive wastes and their management, Radiation standard by ICRP and AERB Waste characteristics, generation, collection, transport and disposal, regulatory aspects of e waste, Global strategy, recycling. Waste characteristics, generation, collection, transport and disposal, regulatory aspects of e waste, Global strategy, recycling.	18	4

Reference Books:

1. Hazardous waste management Charles A. Wentz. Second edition 1995. McGraw Hill International.
2. Integrated solid waste management George Tchobanoglous, Hilary Theisen & Sammuel A. Vigil.
3. Criteria for hazardous waste landfills – CPCB guidelines 2000.
4. Hazardous waste management by Prof. Anjaneyulu.
5. Environmental Sciences by Daniel B. Botkin and Edward A. Keller, Wiley student, 6th edition- 2009.
6. Standard handbook of Hazardous waste treatment and disposal by Harry M. Freeman, McGraw Hill 1997.

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Online	Online
	Prof. P. K. Behera (External member									Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester – I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	1
Course code	**Course Title**		**Course Type**
ENV104	**INSTRUMENTAL TECHNIQUES & ANALYTICAL METHODS IN ENVIRONMENTAL SCIENCE**		CORE
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
5	5	-	-
Maximum Marks	**CIA**		**ESE**
100	25		75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced Instruments and it's technique and empower them to apply this knowledge to with higher-level research as well as in different industries like pharmaceutical, ore industries, cement industries etc.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learner would be able explore and learn about Instrumentation, working principle and application of electrochemical techniques such as principle and application of pH-metery, potentiometery, conductometry, coulometry, polarography, Cyclic Voltametry, Anodic Voltametry, Amperometry and Ion selective Electrodes. Understanding and applying different separation technique of substances of different state of matter and types.	Ap
2	Student will learn about the principle, instrumentation and application of the infrared, FTIR, visible, ultraviolet and Raman and fluorescence spectrometry, Nephelometry and turbidimetry. Understand the complex process of chromatography and it's application	Ap
3	Student would understand the principle, instrumentation and application of atomic absorption (i.e. flame, graphite furnace, hydride generation and cold vapor) spectroscopy and atomic emission (i.e. flame, plasma, spark and arc) spectroscopy. Understand the method of mass spectroscopy and how spectra produced after EMR can be used in separation technique.	Ap
4	The pupil would understand the fundamental as well as the principle, instrumentation and application of X-ray fluorescence spectroscopy (XRF), proton induced X-ray emission spectroscopy (PIXE), *NMR* and ESR spectroscopy.	Ap

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

	Understand the other available methods of separation like gravimetric, volumetric etc. and its analytical science.	

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO	POs											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	2	3	1	3	3	3	3	3	3	3	2	3	2	2
CO2	3	2	2	3	1	3	3	3	3	3	3	3	2	3	2	2
CO3	3	2	2	3	1	3	3	3	3	3	3	3	2	3	2	2
CO4	3	2	2	3	1	3	3	3	3	3	3	3	2	3	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS:

Unit No.	Topics	No. of Lectures	CO No.
1	**Electrochemical Techniques:** Fundamentals of Environmental Chemistry: Stoichiometry, Gibb's energy, Chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclide's. Idea of pH and buffer, Buffer capacity and ionic strength; Principle and application of pH-metery, Potentiometery, Conductometry, Coulometry, Polarography, Voltammetry (cyclic and anode stripping), Amperometry and Ion Selective Electrodes.	18	1
2	**Spectroscopic Techniques:** The basic principle, instrumentation and application of the infrared, FTIR, visible, ultraviolet and Raman and fluorescence spectrometry. Principle, instrumentation and application of atomic absorption (i.e. flame, graphite furnace, hydride generation and cold vapor) spectroscopy and atomic emission (i.e. flame, plasma, spark and arc) spectroscopy. Basic Principle, instrumentation and application of X-ray fluorescence spectroscopy (XRF), Principle, instrumentation and application of mass spectroscopy, types of mass spectroscopy, fragmentation, ionization and characterization of organic and inorganic materials.	18	2
3	**Separation techniques:** Concept and application of separation probes: adsorption, centrifugation, chromatography, crystallization, decantation, demister (vapour), distillation, drying, electrophoresis, elutriation, evaporation, leaching, liquid-liquid extraction, solid phase extraction, flotation, flocculation, filtration, reverse	19	3

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online

	osmosis, dialysis (biochemistry) fractional distillation, fractional freezing, magnetic separation, precipitation, crystallization, sedimentation, sieving, stripping, sublimation, vapour-liquid separation, winnowing and zone refining.		
4	**Chromatography and Miscellaneous methods:** Principle, instrumentation and application of gas, liquid, adsorption, paper, gel, size exclusion, HPLC, TLC, electrophoresis and ion exchange chromatography. Principle, instrumentation and application of classical analytical methods(i.e. gravimetric, volumetric and thermal methods); Automatic analytical methods and Hybrid analytical methods., nephelometry and turbidimetry.	20	4

Books & References

1 G. D. Christian, Analytical Chemistry**,** 6th Ed**,** John Wiley & Sons, 2007.
2 H. A. Strobel and W. R. Heineman, Chemical instrumentation: a systematic approach, Wiley, 1989.
3 H. H. Willard, Instrumental methods of analysis, Van Nostrand, 1981.
4 Z. Marczenko and M. Balcerzak, Separation, preconcentration and spectrophotometry in Inorganic Analysis, Elsevier, 2000.
5 E. B. Sandell and H. Ōnishi, Photometric determination of traces of metals, Wiley, 1978.
6 B. Welz and M. Sperling, Atomic Absorption Spectrometry**,** John Wiley & Sons, 2008
7 Ed Metcalfe, Atomic absorption and emission spectroscopy, J. Wiley, 1987.

	Online				10.05.2024	10/5/24	10.5.24	10/05/2024		**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I
Course Code	Course Title		Course Type
ENV105	**LAB WORK-1**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced practical concepts, in various fields related to Water, Air, Noise etc. empower them to apply this knowledge to solve various environmental problems

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Development of deeper understanding of concepts and experiencing experimental procedures directly	Ap
2	Development of data analysis skills regarding physical characteristics of water	Ap
3	Development of data analysis skills regarding chemical characteristics of water	U
4	Developing analytical skills regarding biological characteristics of water	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	Pos											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	3	2	3	1	3	2	3

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO2	3	3	3	1	1	1	3	3	3	2	1	3	2	3	2	3
CO3	3	3	3	1	1	1	3	3	2	2	2	3	2	3	2	2
CO4	3	3	3	1	1	2	3	1	1	2	1	3	2	3	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation.

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
1	Some Basic Techniques: Preparation of the substance for analysis, Weighing the sample, Solution of the sample, Precipitation, Filtration, Filter papers, Crucibles with permanent porous plates, Washing, precipitates, Drying and igniting precipitates	40	1
2	Determination of physical characteristics of water: temperature, color, odor, turbidity, TSS and solids.	40	2
3	Determination of Chemical Characteristics of water: pH, TDS, conductivity, salinity, hardness, alkalinity, BOD, COD, cations and anions	35	3
4	Determination of Biological Characteristics of water: counts of specific organisms and groups of organisms	35	4

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
						10.05.2024	10/5/24	10.5.24	10/05/2024	10/5/24	Online	Online

M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	1	I
Course Code	Course Title		Course Type
ENV106	**LAB WORK-2**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced practical concepts, in various fields related to Water, Air, Noise etc. empower them to apply this knowledge to solve various environmental problems

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Development of deeper understanding of concepts and experiencing experimental procedures directly	Ap
2	Development of thinking skills (critical, quantitative and qualitative)	Ap
3	Development of data analysis skills and Development of Practical skills, including those involved in working in groups.	U
4	Developing critical thinking for shaping strategies (scientific, social, economic and legal) for environmental protection and conservation of biodiversity, social equity and sustainable development	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	3	3	3	1	3	3	3
CO2	3	3	3	1	1	1	3	2	3	3	3	3	2	3	3	3
CO3	3	3	3	1	1	1	3	3	3	2	3	3	2	3	3	2
CO4	3	3	3	1	1	2	3	1	3	2	1	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
1	Introduction to wastewater analysis: calibration of pH meter, Conductivity meter, TDS meter, Turbidity meter, Rp meter & DO meter.	40	1
2	Determination of physical characteristics of wastewater: temperature, color, odor, turbidity, TSS and solids.	40	2
3	Determination of Chemical Characteristics of wastewater: pH, TDS, conductivity, salinity, hardness, alkalinity, BOD, COD, cations and anions	35	3
4	Determination of Biological Characteristics: counts of specific organisms and groups of organisms	35	4

"

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester – II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	II
Course code	**Course Title**		**Course Type**
ENV201	**ENVIRONMENTAL POLLUTION AND CONTROL: AIR AND WATER**		CORE
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	-	-
Maximum Marks	**CIA**		**ESE**
100	25		75

Learning Objective (LO):

The course aims to a deep understanding about the Air Pollution: Atmosphere and its functions, Physical and chemical properties of atmosphere, natural and anthropogenic sources of atmospheric pollutants

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Major and Minor Pollutants in atmosphere (SOx, NOx, CO2, Fluoride etc.), effect of air pollutants on plants, animals, microorganisms, man, physical structures and materials.	R
2	Understanding about the Water Pollution: History of major water pollution episodes, Sources, Classification and types of Water Pollution, characteristics of domestic, municipal, industrial and agricultural wastes – their effects with special reference to oil and detergents, and Heavy metals (mercury, lead, Arsenic cadmium, chromium), pesticides, and other toxic organic and inorganic constituents. Eutrophication and ecological magnification due to water pollution	U
3	Understanding about the Prevention and Control of Air Pollution: Source-emission inventory, Air quality criteria, Air quality standards (Ambient and Emission Standards), Natural self-cleansing properties of the environment	Ap
4	Understanding about the Prevention and Control of Water Pollution: Water quality standard: Drinking Water quality standard, Irrigation water standard, Stream standard and effluent standard, Selection of appropriate unit operation for ETP to achieve desired standards	Ap

CL: Cognitive Levels (R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

CO-PO/PSO Mapping for the course:

PO	POs											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	2	2	3	2	2	3	3	2	3	3	3	2	3	2	3
CO2	3	2	2	3	2	2	3	3	2	3	3	3	2	3	2	3
CO3	3	2	2	3	2	2	3	3	2	3	3	3	2	3	2	3
CO4	3	2	2	3	2	2	3	3	2	3	3	3	2	3	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
1	**Air Pollution:** Atmosphere and its functions, Physical and chemical properties of atmosphere, , natural and anthropogenic sources of atmospheric pollutants, Major and Minor Pollutants in atmosphere (SOx, NOx,CO2, Fluoride etc.),Gas laws governing the behavior of pollutants in atmosphere, transport and dispersion of pollutants – effect of meteorological and topographical factors, significance of these pollutants and their reactions in the lower and upper atmosphere,, Greenhouses effect, Photochemical smog, Ozone layer depletion Acid rain and their impact. Effect of air pollutants on plants, animals, microorganisms, man, physical structures and materials	20	1
2	**Water Pollution**: History of major water pollution episodes , Sources, Classification and types of Water Pollution, characteristics of domestic, municipal, industrial and agricultural wastes – their effects with special reference to oil and detergents, and Heavy metals (mercury, lead, Arsenic cadmium, chromium), pesticides, and other toxic organics and inorganic constituents, Eutrophication and ecological magnification due to water pollution.	20	2
3	**Prevention and Control of Air Pollution:** Source-emission inventory, Air quality criteria, Air quality standards(Ambient and Emission Standards), Natural self cleansing properties of the environment, Dilution methods for controlling air pollution from stationary source, Prevention Methods for control of gaseous air pollutants (Combustion, Absorption and Adsorption), Methods for control of Particulate air pollutants Mechanical device, Filtration, Wet scrubber, Dry Scrubber, Electrostatic precipitator)	17	3
4	**Prevention and Control of Water Pollution:** Water quality standard: Drinking Water quality standard, Irrigation water standard, Stream standard and effluent standard, Selection of appropriate unit operation for ETP to achieve desired standards. Methods of treatment of waste water: Preliminary Treatment, Primary treatment, (Sedimentation, Equalization and Neutralization, etc.), secondary treatment (Activated Sludge Technique & Trickling Filter) Tertiary treatment methods for waste water treatment (Evaporation, Ion Exchange, Adsorption, Electro dialysis, Electrolytic Recovery, Reverse Osmosis) Characteristics of primary, secondary sludge from effluent treatment plant. Sludge dewatering by sludge thickener, sludge drying	18	4

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

	beds, vacuum filtration and filter press. Sludge disposal and fill and additive in fertilizers.		

Books & References

1 N. de Nevers, Air pollution Control Engineering, Mc Graw Hill, 2000.
2 K. Work and C. F Warner, Air Pollution, its origin & Control, New York, 1997.
3 H. Braur and Y. B. G. Verma, Air Pollution Control Equipment, Springer Verlag, 1981.
4 G. Gaur, Air Pollution and its Management, Sarup & Sons, 1997.
5 R. K. Trivedi and P. K. Goel, Air Pollution, Techno-science, 1998.
6 G. Kiely, Environmental Engineering, Tata MC. Graw Hill, 1997.
7 P. K. Goel, Water Pollution, Causes ,effect and Control, New Age International, 2006.
8 S. K. Garg, Sewage Disposal & Air Pollution Engineering, Khana Publisher, 2008.
9 I. J. Higgins and R. Burns, The Chemistry and ecology of pollution, Academic Press, 1975.
10 S. S. Dara, A text book of Environmental Chemistry and Pollution Control, S. Chand, 1993.
11 A. K. De, Environnental Chemistry, New Age International, 2003.
12 J. W. Moore and E. A. Moore, Environmental Chemistry, Academic Press, 1991.
13 T H Y Tebbut, Principal of water quality control, Pergamon Press, 1992.
14 R. K. Trivedy and S. N. Kaul, Advances in Waste water Treatment and Technologies, Vol. II, Global Science, 2000.

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									**Online**	**Online**

M.Sc. (Environmental Science) Semester – II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	II
Course Code	Course Title		Course Type
ENV202	**METEOROLOGY AND CLIMATOLOGY**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of the characteristics and composition of the Earth's atmosphere , oceanic zones, energy and heat balance. Students will acquire proficiency in the fundamentals of meteorological parameters.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Describes the composition & layers of atmosphere, layered structure of oceans, radiation balance in atmosphere. Explains the Magnetosphere and radiation belts. Understanding different meteorological parameters and their applications.	U
2	Know the heat balance equations & cycles, thermal cycles in soil & water bodies. Understanding the planetary wind circulations & the global patterns of ocean currents.	U
3	Understanding of Relative humidity and vapor pressure, Absolute and specific humidity, air masses, clouds and fog, forms of precipitation, Convective precipitation and thunderstorms, Orographic precipitation, Water balance of the atmosphere.	U
4	Understanding human induced impact on atmosphere & glaciers and studying the harmful effects of pollution on a global scale. Decribing the effects of meteorological parameters on pollutants and vice versa.	U

CL: Cognitive Levels (R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

CO-PO/PSO Mapping for the course

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	1	2	3	1	3	2	1	3	1	1	3	-
CO2	1	3	2	1	1	1	3	-	3	1	3	3	2	1	2	3
CO3	2	1	3	1	1	1	3	-	2	2	3	3	2	2	3	2
CO4	3	3	3	1	1	2	3	1	2	2	1	3	2	2	3	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Atmosphere, Oceans and Earth's Radiation Balance:** Introducing the Atmosphere, The heterosphere, Subdivisions of the homosphere, the troposphere, atmospheric pressure, Introducing the oceans: Composition of Sea water, Density of sea water, Layered structure of Oceans; Solar radiation, Insolation over the Globe, World Latitudinal zones, Insolation losses in the atmosphere, Long wave radiation, Latitude and the radiation balance, Annual and Daily Cycles of radiation, Man's Impact upon the Earth's Energy Balance, Cosmic particles and Ionizing radiation, The magnetosphere, radiation belts Meteorology fundamentals – Pressure, temperature, wind, humidity, radiation, atmospheric stability adiabatic diagrams, turbulence and diffusion. Scales of meteorology.	19	1
II	**Thermal Environments of the Earth's Surface and Circulation Systems in Atmosphere and Oceans :-** Heat flow mechanisms, The Heat Balance Equation, The daily and annual heat balance cycles, Arctic permafrost, Heating and cooling of lakes and oceans, Sea Surface Temperatures, Barometric pressure and winds, Coriolis effect and the geostrophic wind, The Planetary circulation, Global patterns of barometric pressure and surface winds, Local winds, Wind and waves, The causes of ocean currents, Zones of convergence and upwelling, El Nino, ENSO, The Earth's heat balance, Seasons in India. Concept of Monsoon, What are the proxy components helpful in the reconstruction of Indian monsoon, How subterranean caves are helpful in studies of reconstructions of the Indian monsoon. How the Meghalayan Age came into existence.	20	2
III	**Atmospheric Energy Releases:-** Relative humidity and vapor pressure, Absolute and specific humidity, air masses, condensation and adiabatic process, clouds and fog, forms of precipitation, Convective precipitation and thunderstorms, Orographic precipitation, Cyclonic and frontal precipitation, World precipitation regions, Water balance of the atmosphere, Artificial precipitation.	17	3

Online												
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

IV	**Man's Impact upon the Atmosphere:-** Carbon dioxide and oxygen levels in the atmosphere, Man induced changes in Atmospheric temperature, water vapor, clouds, and precipitation, Urban heat island, Pollutants in the atmosphere, Inversion and smog, Glacial ice as a recorder of air pollution, Harmful effects of atmospheric pollution, Global effects of particles in the atmosphere, Application of meteorological principles to transport and diffusion of pollutants, Scavenging processes, Effects of meteorological parameters on pollutants and vice versa, Wind roses, concepts of climate change. & its reasons and impacts	19	4

Books & References:-

1 Helmis C. G. and Nastos, P. T. (Eds.), Advances in Meteorology, Climatology and Atmospheric Physics, Springer Atmospheric Sciences, 2013.
2 P. V. Hobbs and J. M. Wallace, Atmospheric Science: An Introductory Survey, Academic Press Inc, 2006.
3 C. Booker, The Real Global Warming Disaster, Continuum Publishing Corporation, 2009.
4 A. Goudie, The nature of the environment, Blackwell, 2001.
5 K. S. Valdiya, Environmental Geology, Tata Mc Graw Hill, 1984.
6 Atmosphere, Weather and Climatology: A textbook on climatology, Kisalaya Pub. Pvt. Ltd, New Delhi, 1984.
7 R. G. Barry and R. J. Chorley, Atmosphere, Weather and Climate, Routledge, 2009.
8 J. E. Martin**,**Introduction to Weather and Climate Science, Cognella Academic Publishing, 2013.
9 J. O. Ayoade, Introduction to Climatology for Tropics, Wiley, 1993.
10 The Atmosphere: An Introduction to Meteorology, Prentice Hall; 12 edition, 20012.
11 J. Biswas, Cave Science: Insight from the Indian Sub-continent, National Cave Research and Protection Organization, 2022.

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	**Online**	**Online**

M.Sc. (Environmental Science) Semester – II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	2
Course Code	Course Title		Course Type
ENV203	**ENVIRONMENTAL GEOSCIENCE**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

Students will have holistic understanding of the factors influencing & shaping environmental conditions on Earth. They will be able to address the physical, chemical & biological processes that control the world's oceans, atmosphere and ecosystems.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding the different sphere of Earths, formation of different types of rocks, earth dynamic processes: plate tectonics, types of plates, isostasy, geomorphic agents and formation of land forms.	U
2	Understanding the environmental geochemistry, concept of major, trace and rare elements, geochemical classification of elements, abundance of elements in earth, biogeochemical cycle & mineral stability diagrams and controls on the chemistry' of natural waters.	U
3	Understanding the Global water balance, composition of sea water, Precipitation (Various form of precipitation, interpretation of precipitation data), Infiltration and percolation(Infiltration capacity of soil, Factors influencing infiltration capacity, methods of determining infiltration capacity). Hydrological forecasting: Frequency analysis, cyclical nature of hydrological phenomena.	Ap
4	Understanding of Ground Water Resources and Environment, the occurrence of ground water, Darcy's law: Darcy's experiment; Fundamental Equation of ground water flow: Generalization of Darcy's law, Aquifer and its types, Ground water levels and Environmental influences.	E

CL: Cognitive Levels (R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

CO-PO/PSO Mapping for the course

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	1	3	-	1	-	3	1	3	-	-	3	1	2	1	-
CO2	3	3	2	1	1	1	3	-	2	-	2	3	2	1	1	3
CO3	3	1	3	1	1	1	3	-	1	2	-	3	2	2	1	2
CO4	2	2	3	1	1	2	3	1	2	2	1	3	2	1	2	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Fundamentals of Geoscience** Different spheres in the earth: lithosphere, hydrosphere, atmosphere, biosphere; Primary differentiation and formation of core, mantle, crust, magma generation and formation of igneous rocks: earth dynamic processes: plate tectonics, types of plates, isostasy, geomorphic agents: river, wind, snow, glacier, volcanoes, weathering, erosion, transportation and deposition of earth's materials by running water, wind and glaciers: formation of land forms and sedimentary rocks. What is Karst. What are the components of the Karst System. How Caves are formed in Karst areas, Scope of Karst and Cave Science in India. Why the proper management is required for Karst System? What are the Investigative Techniques in Karst.	17	1
II	**Environmental Geochemistry** Concept of major, trace and rare earth element, Geochemical classification of elements: Abundance of elements in the bulk earth, crust, hydrosphere, atmosphere and biosphere. mobility of trace elements, geochemical cycles, biogeochemical factors in environmental health, human use, trace elements and health, Mineral stability diagrams and controls on the chemistry' of natural waters.	17	2
III	**Surface Water Resources and Environment**	20	3

Online Online Online

Prof. Kamlesh. K. Shrivas, Chairman | Prof. P. K. Behera (External member) | Prof. Kallol K. Ghosh (member) | Prof. M. K. Deb (Member) | Prof. Shamsh Pervez (Member) | Dr. Karuna dubey (member) | Dr. Bhanushrre Gupta (Memebr) | Dr. Ajita Dixt (Member) | Shri H. Deshmukh (Member) | Shri B. L. Yadaw (Member) | Dr. Indrapal Karbhal (Member) | Dr. Anand Kamavisdar (Member from DST)

	Global water balance, ice sheets and fluctuation of sea levels, origin and composition of sea water, hydrological cycle, and its components. Precipitation (Various form of precipitation, interpretation of precipitation data), Evaporation and Evapo-transpiration (Meteorological factors, transpiration, methods of estimating evaporation from land surface using Penman's equation), Infiltration and percolation (Infiltration capacity of soil, Factors influencing infiltration capacity, methods of determining infiltration capacity). Hydrological forecasting: Frequency analysis, series of events, Probability plotting, cyclical nature of hydrological phenomena. Artificial precipitation.		
IV	**Ground Water Resources and Environment** The occurrence of ground water factors of influence, ground water flow, abstraction of ground water, Darcy's law: Darcy's experiment; Fundamental Equation of ground water flow: Generalization of Darcy's law. Aquifer and its types; Confined and Unconfined aquifers; Properties of Aquifer, permeability, porosity. Groundwater occurrence & movement; Ground water levels and Environmental influences.	**21**	**4**

Books & References:-

1. Environmental Geology: Indian Context by K. S.Valdiya ,Tata Macgraw Hill
2. Environmental Science : E. D. Enger and B. F. Smith
3. Introduction to Geochemistry : Krauskoph K. B.
4. Geology and our environment, Davis, S. N. , Reiton, P. H.& Pestrong, P. Mc.Graw Hill, NY
5. Environmental Geology, Keller, E,.A., Bell &Howell, Columbus, Ohio
6. Physical Geology, Strahler, A. N., John Harper & Row
7. Focus on Environmental Geology, Tank, R.W.Oxford Univ. Press
8. Text Book of Geology, P. K. Mukherjee
9. Environmental geology, Coates, D. R. , John wiley, NY
10. J. Biswas, Cave Science: Insight from the Indian Sub-continent, National Cave Research and Protection Organization, 2022.

	Online				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	II
Course Code	**Course Title**		**Course Type**
ENV204	**WATER AND WASTEWATER TREATMENT TECHNOLOGIES**		ELECTIVE
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
5	5	-	-
Maximum Marks	**CIA**		**ESE**
100	25		75

Learning Objective (LO):

The course aims to equip students with a deep understanding of water and wastewater, wastewater treatment, water quality standard, and them to apply this knowledge to minimize water pollution and learn wastewater management.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	After studying this unit students will be able to understand the water and its types, characteristics of water, various stages of water treatment.	U
2	Understand the characteristics of waste water and treatment plant effluents, methods of treatment of waste water: preliminary treatment. primary treatment. (sedimentation. equalization and neutralization. etc.) secondary treatment (activated sludge technique & trickling filter).	Ap
3	Tertiary treatment methods for waste water treatment (evaporation. ion exchange adsorption, electro dialysis, electrolytic recovery. reverse osmosis)	Ap
4	Understand about the prevention and control of water pollution: water quality standard: drinking water quality standard, irrigation water standard, stream standard and effluent standard. Selection of appropriate unit operation for LTPto achieve desired standards	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	1	3	2	3	2	2	2	2	3	1	2	1	2
CO2	3	3	3	2	2	2	3	2	3	3	3	3	2	2	1	3
CO3	3	3	3	2	2	1	3	2	3	3	3	3	2	2	1	2
CO4	3	3	3	2	3	2	3	2	3	3	3	3	2	2	1	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Water Pollutants and Treatment** Types and Sources, quality of water (water, sewage and industrial wastewater), various stages of water treatment flocculation and coagulation, Sedimentation, Filtration: slow and rapid sand filters, disinfection	10	1
II	**Wastewater Treatment** Characterization and degree of treatment-Self purification in a stream, characteristics of waste water and treatment plant effluents, Dissolved oxygen, Esturine pollution **Primary treatment**: Screening, Grit removal, Neutralization, Equalization, Coagulation, Flocculation, Sedimentation, Flotation (oil & grease removal), Air stripping **Secondary treatment**- principles of waste treatment, basic kinetic equations, continuous flow treatment models, oxygen requirement in aerobic process, production of sludge. Conventional biological process: Activated Sludge Process (ASP), UASB, Trickling Filters and RBC, ***Nitrogen removal***: Nitrification and denitrification process, phosphorous removal. Low cost wastewater treatment: Aerated lagoons, stabilization ponds, oxidation ditches.	25	2
III	**Tertiary Treatment of Wastewater** Tertiary treatment-ion exchange, ***Membrane separation Techniques:*** Brief description of MF, UF, NF membranes.	20	3

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

	Reverse osmosis principle, Membrane materials , Types of membranes – Plate & frame , tubular, hollow fibre , spiral wound membranes, application of membranes in various industrial applications., ***electro chemical techniques***: electro dialysis, electro coagulation, ***Evaporators***: forced evaporation , Multiple effect evaporators – falling film , raising film , forced circulation , agitated thin film driers. Advanced oxidation process, photo catalysis, Ozonation, Fenton process, Hydrodynamic cavitation.		
IV	**Sewage and Industrial Wastewater Treatment and Disposal** Introduction, importance of sewage, Characteristics of sewage, Sewage treatment and disposal: Grit chamber, Sedimentation tanks, Secondary treatment: Activated sludge process, sludge digestion. Sludge disposal. Septic tank. Sources, Characteristics, methodology and process for the treatment of industrial wastes of sugar industry- beverage industry- tannery industry- textile mill waste industry- fertilizer plant- steel plant- oil refinery-paper and pulp mill. Legislation, Cleaner technologies: Water conservation, By-product recovery, Zero liquid discharge (ZLD).	20	4

Books & References

1. Water Supply and Sanitary Engineering G.S.Bridie & J.S.Brides, Dhanpat Rai & Sons 1993.
2. A treatise on Rural, Municipal, and industrial water management KVSG Murali Krishna
3. Environmental sanitation (Social and Preventive medicine) Dr. P.V. Rama Raju & KVSG Murali Krishna.
4. Waste water engineering, treatment and reuse by Metcalf and eddy, fifth edition, Tata Mc Graw Hill.
5. Municipal and Rural Sanitation-Ehlers, V.M.&Steel, E.W. McGRAW-HILL Book Company, Inc V. edition. 1987.

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	II
Course Code	Course Title		Course Type
ENV205	**ENVIRONMENTAL POLLUTION AND CONTROL: SOIL, RADIATION AND NOISE (II)**		Elective
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of soil properties and soil chemistry bio-magnification of heavy metals and pesticides, fate of MSW, BMW, HW and radioactive pollution and management, noise pollution and its impacts on human and Environment. Overall student can analyze various aspects of pollution and its prevention.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding about physiochemical properties of soil, industrial waste types, heavy metal contamination, source translocation and uptake of heavy metals, pollution due to pesticide in soil, alternate methods of pest control, pollution due to fertilizers(N,P,K)	U
2	Municipal solid waste -source ,nature, and characterization, management of solid and hazardous solid waste, Hazardous and biomedical waste -all point of view, guidelines for HWM and biomedical waste management. Fly ash and red mud treatment and disposal	Ap
3	Radioactivity- discovery, measuring units and definition, source and classification of radioactive pollution, mechanism of radiation action on living system. Protection and control from radiation, disposal of radioactive waste	An
4	Sound waves (spherical and plane wave), noise sources, effect of noise on human health, noise standards and limit value. Prevention and control of noise pollution.	E

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Online	Online
											Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

CO / PO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	3	3	3	2	9	3	3	3	3	3	2	3
CO2	3	3	3	2	3	3	3	2	3	3	3	3	3	3	2	3
CO3	3	3	3	3	3	3	3	2	3	3	3	3	2	3	2	3
CO4	3	3	3	2	3	3	3	2	3	3	3	3	2	3	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Soil Pollution and Control** The nature and importance of soil. Physical and Chemical properties of soil, Industrial wastes of different kinds, their interactions with soil components, problems due to toxic heavy metals and. Contamination of radionuclides, Source translocation, distribution and uptake of heavy metals, toxic and ecological effect, Pollution due to pesticides in soil, persistence, fate and degradation of pesticides in soil, Toxicity and effect of pesticides on soil organisms and plants, Alternate methods of pest control: Biological control, Hormonal control, Integrated pest management, Pollution due to fertilizers (N, P and K) and their interactions with different components of soil.	20	1
II	**Solid Waste Pollution and Control** Sources, nature and characterization of municipal solid waste, Hazards from these solid waste, various methods of disposal and management of solid and hazardous waste (composting, recycling, bio-methanation, pelletisation, pyrolysis, incineration, gasification, sanitary disposal etc.), hazardous and biomedical waste: categorization, generation, collection, transport, treatment and disposal, Hazardous waste and biomedical waste.	19	2
III	**Radiation Pollution and Control** Discovery' of Radioactivity, Units of measurement and definition of radioactivity, Sources and Classification of radioactive pollution, Methods of radioactivity measurements, biological pathways, transport and effects of radiation, Mechanism of Radiation action on living system – Stochastic and Non-stochastic effects: delayed effects; protection and control from radiation, disposal of radioactive waste.	18	3
IV	**Noise Pollution and Control** Basic properties of sound waves-plane and spherical waves, sound pressure and intensity levels, decibel, effect of meteorological parameters on sound propagation. Noise sources; (machinery noise, pumps; compressors, building and construction equipment, domestic appliances, traffic – vehicular, train,	18	4

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	Online									Online	Online

	aircraft) effect of noise on human health, noise standards and limit values. Prevention and control of Noise Pollution (sound absorbing materials, reverberation time, acoustic silencers, mufflers, barriers, vibration and impact isolation, anechoic chamber, greenbelt development).		

Reference Books:

1 S. E. Manahan, Environmental chemistry. Lewis Publ., 1992
2 A.P. Sincero and G.A. Sincero, Environmental Engineering, Prentice, 1996.
3 C. S. Rao, Environmental Pollution Control Engineering, Willey Estern, 2007
4 P. F. Cunniff, Environmental noise pollution, Wiley, 1977.
5 A. Farmer, Handbook of Environmental Protection and Enforcement: Principles and Practice, Earthscan, 2007.
6 S. Dara, Textbook of Environmental Chemistry and Pollution Control, Chand (S.) & Co Ltd ,2006.
7 H. J. Arnikar, Essential of Nuclear Chemistry: New Age International Publishers, 2011
8 P. R.Trivedi and Raj G. (Eds.) Encyclopaedia of Environmental Sciences: Solid Waste Pollution Vol.24. Akashdeep, Publishing House, 1992.
9 D. Mani and S. G. Mishra, Soil Pollution, APH Publishing, 2009.
10 P. K. Gupta, Pesticides in Indian Environment, Interprint, 1986
11 H. D. Forth, Fundamentals of Soil Sciences : New York : Wiley, 1990
12 T. D. Biswas and S. K. Mukherjee, Text-Book of Soil Sciences, Tata McGraw-Hill, 1987

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Online	Online
	Prof. P. K. Behera (External member									Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I I
Course Code	Course Title		Course Type
ENV206	**LAB WORK-3**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced algebraic concepts, particularly in groups and field theory, and empower them to apply this knowledge to solve mathematical problems and engage with higher-level algebraic research. To develop various processes/skills e.g. observation, discussion, explanation, experimentation, logical reasoning, through interaction with immediate surroundings. develop sensitivity for the natural, physical and human resources in the immediate environment.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Development of deeper understanding of concepts of soil characteristics.	Ap
2	Experiencing experimental procedures directly and Development of analytical skills regarding chemical properties of soil.	Ap
3	Development of Practical skills of soil organic matter and concentration of fertilizer in soil.	U
4	Development of Practical skills of heavy metal toxicity and its possible harmful impacts.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

Online					10.05.2024	10/5/24					Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)	

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	3	3	3	1	3	2	-
CO2	3	3	3	1	1	1	3	2	3	2	2	3	2	3	2	3
CO3	3	3	3	1	1	1	3	3	3	2	1	3	2	3	2	2
CO4	3	3	3	1	1	2	3	1	3	2	1	3	2	3	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
1	Determination of Specific Gravity, Bulk Density and Moisture Content of a given soil sample.	35	1
2	Determination of Sodium, Potassium, Lithium and Calcium of soil sample by using flame Photometer.	35	2
3	Determination of Organic Carbon, NPK and CEC of a given soil sample.	40	3
4	Determination of Bioavailable and Total Heavy Metals in soil.	40	4

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						10.05.2024	10/5/24	10.5.24	10/05/2024	10/5/24		

M.Sc. (Environmental Science) Semester-II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	II
Course Code	Course Title		Course Type
ENV207	**LAB WORK-4**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced algebraic concepts, particularly in groups and field theory, and empower them to apply this knowledge to solve mathematical problems and engage with higher-level algebraic research. To develop various processes/skills e.g. observation, discussion, explanation, experimentation, logical reasoning, through interaction with immediate surroundings. develop sensitivity for the natural, physical and human resources in the immediate environment.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Reporting of ambient PM10 and PM2.5.	Ap
2	Ambient measurement of SO2, NO2 using a solvent absorption method and CO & CO2 monitoring.	Ap
3	Measurement of ambient noise & traffic noise.	U
4	Preparation of noise contour map.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

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Online										Online	Online

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	-	-	3	1	-	-	-
CO2	3	3	3	1	1	1	3	-	-	-	-	3	2	-	-	3
CO3	3	3	3	1	1	1	3	-	-	2	-	3	2	-	-	2
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	Calibration and Determination of SPM/PM10/PM 2.5 in ambient air by using air sampler.	40	1
2	Determination of CO, CO_2, SO_2 and NO_2 in ambient air.	40	2
3	Determination of Ambient noise monitoring& Traffic Noise Monitoring.	35	3
4	Noise survey and development of noise profile in a multiple noise sources situation.	35	4

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester – III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course code	**Course Title**		**Course Type**
ENV301	**ENVIRONMENTAL TOXICOLOGY**		CORE
Credit	**Hours Per Week (L-T-P)**		
	L	**T**	**P**
5	5	-	-
Maximum Marks	**CIA**		**ESE**
100	25		75

Learning Objective (LO):
The course aims to a deep understanding about the toxicology of toxic substance whether they could impact changes in behavior.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Introducing Toxicology and its History, disciplines and importance of toxicology	U
2	Study of Translocation of Toxicity, Absorption, Distribution and Excretion of toxic substances	U
3	Biotransformation and Bioaccumulation of Toxicants in living oraganism and physical environment.	An
4	Understanding of Toxicity Tests, Safety Evaluation of Chemicals and Safety measures and Health Impacts.	An

CL: Cognitive Levels (R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	2	7	8	9	10	11	1	2	3	4	5
CO1	3	1	2	3	1	2	3	3	2	3	3	3	2	-	2	2
CO2	3	1	2	3	1	2	3	3	2	3	3	3	2	2	2	2
CO3	3	1	2	3	1	2	3	3	2	3	3	3	2	2	2	2
CO4	3	1	2	3	1	2	3	3	2	3	3	3	2	2	2	2

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
1	**Introducing Toxicology:** History, disciplines and importance of toxicology, Potency and Toxicity, Acute toxicity, chronic toxicity), Hazards, Risks, Benefit-to-risk-ratio, tolerance limits, Acceptable daily intake, Threshold value. Factors affecting toxicity : Host factor (Age ,species and strain, sex, life stage, health and nutrition, Idiosyncratic toxicity) interaction between chemicals (synergistic, additive and antagonistic).Environmental factors, Physico-chemical properties of toxic substances, route and rate of exposure, Dose, Effect and response, Dose-response curves , & Dose effect relationships (Graded & Quantal response). Statistical concept of toxicity, margin of safety and therapeutic index	19	1
2	**Translocation of Toxicity:** Absorption, Distribution and Excretion of toxic substances. Absorption: membrane permeability, mechanism of chemical transfer (passive transport, active transport, facilitated transport), absorption (Gastrointestinal, skin, lungs). Distribution: tissue affecting distributions and tissues retention. Excretion: Renal excretion, Biliary excretion and Gastrointestinal. Receptor Concept, Nature of receptors, Theory of toxicant receptor interaction, Mechanism of action of some Pesticides (organochlorine, carbamate and organophosphate) and heavy metals (lead, arsenic, mercury, cadmium and chromium)	18	2
3	**Biotransformation and Bioaccumulation of Toxicants:** Site, Biotransformation reactions, Phase-I (Oxidation, Reduction, Hydrolysis) and Phase- II (Conjugation) reactions and associated enzymes (cytochrome P450 system, cytochrome-b5 system, amine oxidase epoxide hydrolase, esterases and amidases, glutathione-s-transferase),factors(environmental, chemical and organismal) affecting biotransformation of xenobiotics, concept of bioconcentration, bioaccumulation and biomagnifications. Process of accumulation and elimination of toxicants	20	3
4	**Toxicity Tests and Safety Evaluation of Chemicals:** Toxicity tests: Types of toxicity test based on number of species(single species ,Multipecies and Ecosystem tests) , based on exposure(single dose and multiple dose) , based on duration of exposure (acute and chronic toxicity test), specific toxicity tests(potentiation, teratogenicity, reproductive ,carcinogenicity, skin, eye tests), safety evaluation of chemicals : introduction and definition of safety, process of risk assessment and safety evaluation programmer (nature of chemical, usage pattern, environmental level & fate, human exposure & effect, monitoring, surveillance and follow-up, decision making).	18	4

Books and References

1. Toxicology Vol I ,II and III : Gupta, Metropolitan
2. Experimental toxicology : Anderson & Conning

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	Online									Online	Online

3. Environmental Pollution and Toxicology: Ray Choudhury & Gupta, Today & Tomorrow Pub.
4. Toxicology, Omkar
5. Toxicology, Sood, Sarup and Sons

M.Sc. (Environmental Science) Semester-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV302	**ENVIRONMENTAL MICROBIOLOGY**		Core
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding environmental concept, principals and the world of microorganisms from the point-view of interaction and reaction of microbial impacts and role of microorganisms in the environment. Control and resolve environmental problems that affect our live. Characterized the microorganisms and their activities exists in air, water and soil environment in combination with factors that influencing their activity and development. Microbial community dynamics, Microbial habitats (air, soil, subsurface, freshwater, marine and the deep sea), Natural microbial communities with emphasis on biofilms, Also, it covered biodeterioration and biodegradation of the environmental pollutants. Microbial interactions: microbe-microbe interactions, plants as microbial habitats, animals as microbial habitats.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	After studying this paper (Course), students will be able to - Understand about Fundamentals of Environmental Microbiology, An overview of microbial diversity, Distribution of microbes in air and water	Ap
2	Learn the Microbial Culture, Enumeration, Growth and Metabolism process. Summarize the microbe-microbe interaction, microbe-plant interaction, microbe-animal interaction	Ap

Online										Online	Online
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3	Understand the Control of Microorganisms by physical, Chemical and chemotherapeutic agents with the mode of action including various antibiotics.	U
4	Understand the Applied Microbiology such as. Microbes used as bio fertilizer, Bio pesticides, Single cell protein, Mycorrhizae and their significance, Microbial leaching of metals, Microorganisms as source of fuel. Learn lots of knowledge about role of microbes in the synthesis of Alcohol, organometallic compound, Application of microbes for biological treatment of waste water, microbiological biodegradation of Industrial wastes	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	2	2	3	1	3	2	1
CO2	3	3	3	1	1	1	3	2	3	2	1	3	2	3	2	3
CO3	3	3	3	1	1	1	3	2	3	2	1	3	2	3	2	2
CO4	3	3	3	1	1	2	3	1	3	2	1	3	2	3	2	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Fundamentals of Environmental Microbiology** An over view of microbial diversity (Archaea, Eubacteria, Eukaryotic microbes) cellular organization of bacteria and their types and distribution, microorganisms as component of the environment. Distribution of microbes in air, Allergic disorders by air microflora fungal and pollen allergens. The microbial community in Marine and Fresh water environments. Microbiology of soil – soil habitats, Nutritional types of microorganisms.	20	1
II	**Microbial Culture, Enumeration, Growth and Metabolism** Concept of microbial culture (culture media, culture techniques like enrichment culture, pure, synchronous and continuous culture), Collection and enumeration of aeroallergens. Bacteriological analysis of water, sewage and waste water. Microbial examination of milk & dairy products. Microbial growth (different growth phases,	18	2

Online					10.05.2024	10/5/24	10.5.24	10/05/2024		Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

	multiplication and kinetics of growth) and microbial metabolism (aerobic, anaerobic, fermentative pathways)		
III	**Control of Microorganisms** Physical agents (temperature, pressure, radiation), chemical agent (bacteriocidal and bacteriostatic compounds, halogens and phenolic) for control of microbes, chemotherapeutic agents (drugs and antibiotics) and their mode of action	18	3
IV	**Applied Microbiology** Microbes as biofertilizers, biopesticides and single cell protein, mycorrhiza and their significance, microbial leaching of metals, microorganisms as source of fuel, role of microbes in the synthesis of Alcohols, Antibiotics, Amino acids, dairy products enzymes, vitamin productions and other organic acids.	20	4

Books Recommended

1. Microbiology – Fundamentals and application R.M.Atlas ,Maxwell-Mcmillan International Ed. 1996
2. Broke –Biology of Microorganisms M.T. Madigan , J.M Martinko and J.Parker ,Prentice Hall International 1998
3. Microbiology -L.M. Prescott, J.P. Harley and D.A. Klein, Tata Mc Graw Hill 2003

References Books:

1 Fundamentals of Microbiology and immunology, A.K. Banerjee and N. Banerjee ,Central Book Deport 2006

2. Microbiology -Michael J. Pelzer, Tata Mcgraw Hill

1. Microbes, Man and Animals : The Natural History of Microbial Interactions : Linton, A. H. and Burns, R.G. (1982) john Wiley and Sons.
2. Elements of Microbiology : Pelczar, M.J. and Chan ECS, 1981 McGraw Hill.

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester – III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	3
Course Code	Course Title		Course Type
ENV303	**DATA ANALYSIS IN ENVIRONMENTAL SCIENCE**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

Recognize, describe, and calculate the measures of data: quartiles and percentiles, the measures of the center of data: mean, median, and mode. Recognize, describe, and calculate the measures of the spread of data: variance, standard deviation, and range.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understanding different types of data and its representation in different graphical formats. Knowing sampling methods and experimental designs.	U
2	Understanding and calculating central tendencies & measure of dispersion.	E
3	Understanding of Binomial, Poisson and normal distribution; Testing of Hypothesis: Null and Alternative Hypothesis & understanding and application Student's t distribution, Chi-square test.	U
4	Understanding & calculation of correlation & regression & application of ANOVA (analysis of variance)	E

CL: Cognitive Levels (R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create).

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	Online									Online	Online

CO-PO/PSO Mapping for the course

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	1	-	1	-	3	1	-	2	3	3	1	-	2	-
CO2	1	3	2	1	1	1	3	1	2	-	2	3	2	3	2	3
CO3	3	2	3	1	1	1	3	-	3	2	-	3	2	2	1	2
CO4	3	3	1	1	1	2	3	1	-	2	1	3	2	-	3	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Fundamentals of Statistics** Population & sample, Variables, Primary and secondary data, Collection of data, Classification and tabulation of data, Need and usefulness of Diagrams & Graphs, Different types of diagrams and graphs. Frequency distribution: Discrete and continuous frequency distribution, sampling methods (random sampling, Stratified random sampling, Systematic sampling), sampling errors, Experimental design: completely randomized block design, randomized block design, Latin square design.	17	1
II	**Descriptive Statistics** Measure of central tendency (Averages), Types of mean: Arithmetic mean, Geometric mean, Harmonic mean; Median, Mode, relation between mean median and mode; Measure of dispersion: Range, Mean deviation & Standard deviation; Skewness and Kurtosis .	21	2
III	**Theoretical Probability Distribution** Binomial, Poisson and normal distribution; Testing of Hypothesis: Null and Alternative Hypothesis, level of significance, Student's t distribution and its application, Chi-square(x^2) test & its application.	19	3
IV	**Correlation, Regression and ANOVA Analysis** Types of correlation; simple, partial and multiple correlation, Method of study & testing the significance of correlation	18	4

Online Online Online

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	coefficient, Rank correlation, Regression analysis: regression equations and regression lines, Properties of regression lines, regression coefficient, testing the significance of regression coefficient. Analysis of variance (ANOVA): One way and two way classification and their applications.		

Books & References:-

1. Walpole, R. and R. Myers (1993). Statistics for Engineers and Scientists, 5th edn. MacMillan, N.Y.

2. Manly (2001) Statistics for environmental science and management, Chapman and Hall / CRC.

3. Statistics : Gupta, Sultan & Chand
4. Fundamental of Statistics: Elhance
5. Biostatics: Mishra & Mishra
6. Statistical Methods: Snedecor and Cochran
7. Introduction to Biostatistics by N. Gurumani, MJB Publisher

M.Sc. (Environmental Science) Semester-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV304	**ENVIRONMENTAL BIOTECHNOLOGY**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The aim of this course is to make students proficient in understanding of advanced applications in biotechnology including bioremediation, phytoremediation, biotechnology for air & water pollution and solid waste management. Through this knowledge, they will develop a strong foundation in practical application of biotechnology to addresses environmental problems.

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	After studying this unit students will be able to understand the Bioremediation and its types, role of microbes in biodegradation of xenobiotic compounds, Biosorption & bioleaching. bioindicators, biomarkers and biosensor in waste treatment	Ap
2	Understand the Various methods to treat contaminated sites & wastelands. Bioremediation of contaminated soils, aquifers and industrial waste. Phytoremediation and hyperaccumulator plants.	Ap
3	Students will understand the air and water pollution reduction techniques in biotechnology. The different treatment like aerobic & anaerobic biological process	Ap
4	Understanding the biotechnology for solid waste management. Composting of solid waste and different techniques: vermicomposting and its types.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	2	2	3	2	3	2	2	2	3
CO2	3	3	3	1	1	1	2	2	3	3	1	3	2	3	2	3
CO3	3	3	3	2	2	3	2	2	2	2	2	3	2	3	2	3
CO4	3	3	3	1	1	2	3	1	2	2	1	3	2	3	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Bioremediation** Scope of bioremediation; types of bioremediation (Natural, solid phase, slurry phase and bioventing); applications of bioremediation; Bioremediation efficacy testing; Approaches to bioremediation; Role of microbes in biodegradation of xenobiotic compounds:- halocarbons, polychlorinated biphenyls, alkyl benzyl sulfonates and oil mixtures, biodegradation of pesticides, enzyme catalyzed pesticide degradation reactions. Biosorption, biomineralisation & bioleaching, mechanisms of bioleaching, Bio indicators, Biomarkers and Biosensors in waste treatment.	17	1

Online Online Online

Prof. Kamlesh. K. Shrivas, Chairman | Prof. P. K. Behera (External member) | Prof. Kallol K. Ghosh (member) | Prof. M. K. Deb (Member) | Prof. Shamsh Pervez (Member) | Dr. Karuna dubey (member) | Dr. Bhanushrre Gupta (Memebr) | Dr. Ajita Dixt (Member) | Shri H. Deshmukh (Member) | Shri B. L. Yadaw (Member) | Dr. Indrapal Karbhal (Member) | Dr. Anand Kamavisdar (Member from DST)

II	**Bioremediation of Contaminated Sites, Wastelands and Industrial Wastes** Bioremediation of contaminated soils (natural attenuation and in-situ subsurface bioremediation) and aquifers (Root Zone Technology) bioremediation in aquaculture, Bioremediation of industrial wastes (distillery, pulp and paper, tannery, textile and dye , dairy and food processing). Phytoremediation (phyto-extraction, phyto-stabilization, phytovolatilaztion, rhizodegradation and rhizofilteration), phytoremediation of inorganic, metallic and organic pollutants in contaminated sites, bioremediation of problematic soil.	20	2
III	**Biotechnology for Air and water Pollution Abatement** Air Pollution abatement: Bio-scrubber and Bio-filter, Water Pollution Abatement: Aerobic (Activated Sludge Process, Career advanced Activated Sludge Process, Biological Filters ,Rotating Biological Contractors, Fluidized Bed Reactors, Inverse Fluidized and Bed Biofilm Reactor, Expanded Bed Reactor) Anaerobic Biological Treatment (Contact digester, Packed bed or Packed Volume Reactor , Anaerobic baffled digester, Up flow anaerobic sludge blanket reactors), Membrane Bioreactor and Biocatalyst.	18	3
IV	**Biotechnology for Solid Waste Management** Potential availability and composition of crop residues and other solid organic wastes. Principles of microbial Composting, Factor influencing composting. Methods of composting (aerobic and anaerobic). Vermicomposting. Method of vermicomposting Changes during vermicomposting, aquatic plant, organic wastes and energy crops for biogas, alcohol and hydrogen production using microorganisms, bioconversion of agricultural, Sewage sludge, Paper waste, sugar mill wastes, tannery sludge) to feed stuffs and fertilizers.	20	4

Books & References

1. Wastewater Engineering Treatment disposal Reuse – Metacalf & Eddy Inc. 4th ed TMGHI, New Delhi, 2003
2. Environmental Engineering Peavy, HS, Donald RR & G Tchobanoglous MGH Int. Ed. New York 1985

	Online				10.05.2024	10/5/24	10.5.24	10/05/2024			**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

3. Wastewater Treatment for Pollution Control – Soil J Arceivala, Tata Mc Graw Hill 2nd ed. 1998
4. Wastewater Treatment Plants: Planning, Design and Operation- S.R. Qasim, Holt, Rinehart & Winston, 1985
5. Industrial Water Pollution Control – WW Eckenfelder, Jr. McGraw Hill 2nd Edition NY 1989
6. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publisher
7. Waste Water Engineering, G.L Karia & R.A Christian, Prentice Hill Publication,2nd Edition, 2006.
8. Microbial Methods for Environmental Biotechnology: Grainer, J.M. and Lynch, J.M. 1984. Academic Press.
9. Methods in Biotechnology: Hans Peter Schmauder
10. Global environmental Biotechnology: D. L. Wise
11. Basic environmental technology: Jerry A. Nathanson.
12. Basic Biotechnology Ed. Colin Ratledge & B Jorn Kristiasen, Cambridge.
13. Environmental Biotechnology S.K. Agarwal, APH
14. Managing Industrial Pollution S.K. Bhatia, MacMillan
15. Biological and Biotechnological control of insect Pests, Rechcigl and Rechcigl, Lewis
16. Hand book of Bioremediation, Norris et al., Lewis
17. Micro-organism in Action: Lynch & Hobbie
18. Soil Biotechnology: Lynch Blackwel
19. Waste Recycling for energy conversion: Kutand and Hare, Johnwiley and Sons, N Y.
20. Refuse Recycling: Holms, John wiley & Sons, New York

M.Sc. (Environmental Science) Semester-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	**Course Title**		**Course Type**
ENV305	**LAB WORK-5**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
2+1	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
						10.05.2024	10/5/24	10.5.24	10/05/2024	10/5/24	Online	Online

Learning Objective (LO):

The course aims to equip students with a deep understanding and knowledge of advanced practical concepts related to air, water, soil, etc. particularly in groups and field theory, and empower them to apply this knowledge to solve various environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Determination & Identification of gram positive and gram negative bacteria.	Ap
2	Experiencing experimental procedures of bacteriological analysis of wastewater.	Ap
3	Understanding of heavy metal analysis in water.	U
4	Development of analytical skills for COD, BOD & TOC determination.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	-	-	3	1	-	-	-
CO2	3	3	3	1	1	1	3	-	-	-	-	3	2	-	-	3
CO3	3	3	3	1	1	1	3	-	-	2	-	3	2	-	-	2
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	Gram staining techniques for detection of gram positive and gram-negative bacteria.	40	1
2	Bacteriology of drinking water and domestic sewage -MPN techniques for total coliform, Faecal coliform and Faecal Streptococci (FS)	40	2
3	Determination of heavy metal such as Zn, Ni, Fe, Pb and Cr by Atomic absorption spectroscopy (AAS) in municipal wastewater.	35	3
4	Determination of Chemical Oxygen Demand, TOC & BOD of given wastewater sample.	35	4

***Some advanced level sophisticated instrument based (FTIR, GC-MS, AAS, Ion Chromatography etc.) experiments may be given to the students.**

*** *Internship of 60 Hours (select only one: ENV305 or ENV306) will be guided by the Mentor Faculty**

M.Sc. (Environmental Science) Semester-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV306	**LAB WORK-6**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
2+1	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

Learning Objective (LO):

The course aims to equip students with a deep understanding and knowledge of advanced practical concepts related to air, water, soil, etc. particularly in groups and field theory, and empower them to apply this knowledge to solve various environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Statistical Analysis and research application by using mean, median, mode, Standard deviation & Relative Standard Deviation.	Ap
2	Development of deeper understanding of concepts of essential oils, its extraction & its medicinal use.	Ap
3	Understanding the concept of transesterification & esterification.	U
4	Analysis of energy content and fertilizer content of biodegradable waste and its management.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	-	1	-	3	1	-	-	-	3	1	-	-	-
CO2	3	3	3	1	1	1	3	-	-	-	-	3	2	-	-	3
CO3	3	3	3	1	1	1	3	-	-	2	-	3	2	-	-	2
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	To determine mean, median, standard deviation, relative standard deviation of weight box & 10 mini bottles.	40	1

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									Online	Online

2	To Determine the Oil % of given leaf sample by using Clevenger Apparatus (Heavier than Water & Lighter than water).	40	2
3	Formation of Biodiesel by using using used oil through transesterification and formation of soap & handwash liquid.	35	3
4	Production of biogas and organic manure by using biodegradable waste materials by using mini biogas plant.	35	4

***Some advanced level sophisticated instrument based (FTIR, GC-MS, AAS, Ion Chromatography etc.) experiments may be given to the students.**

* *Internship of 60 Hours will be guided by the Mentor Faculty

	Online				10.05.2024	10/5/24		10/05/2024		**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	IV
Course Code	Course Title		Course Type
ENV401	**ENVIRONMENTAL IMPACT ASSESSMENT, ENVIRONMENTAL AUDIT AND ENVIRONMENTAL MANAGEMENT SYSTEM STANDARDS (EIA, EA AND EMSS)**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced environmental impact concepts, particularly in groups and field theory, and empower them to apply this knowledge to solve various environmental management system standards problems and engage with higher-level research problems.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	After studying this unit students will be able to understand the nexus between environment & development, Origin & development of EIA and overall EIA process.	Ap
2	Understanding about the Case Studies on EIA of different projects & industries.	Ap
3	Understanding about the concept of environmental audit, audit methodology, audit report audit assessing, economic & environmental benefits direct from environmental audit, life cycle assessment.	U

Online Online Online

Prof. Kamlesh. K. Shrivas, Chairman | Prof. P. K. Behera (External member) | Prof. Kallol K. Ghosh (member) | Prof. M. K. Deb (Member) | Prof. Shamsh Pervez (Member) | Dr. Karuna dubey (member) | Dr. Bhanushrre Gupta (Memebr) | Dr. Ajita Dixt (Member) | Shri H. Deshmukh (Member) | Shri B. L. Yadaw (Member) | Dr. Indrapal Karbhal (Member) | Dr. Anand Kamavisdar (Member from DST)

4	Understanding about the Environmental Management System Standards, EMS standard (ISO 9000 & 14000 series), evolution, principles and structure, supporting systems, EMS specification standards & Certification procedures.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	1	3	3	1	3	3	3	3	1	3	3	3
CO2	3	3	3	1	1	1	3	3	3	3	3	3	2	3	3	3
CO3	3	3	3	1	1	1	3	3	3	2	3	3	2	3	2	3
CO4	3	3	3	1	1	2	3	1	3	2	1	3	2	3	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Origin and Development of EIA** Nexus between Development and Environment, Comparison between economic and Ecological criteria, Concept of externalities, shared resources, Global commons & carrying capacities. Origin and Development of EIA. Relationship of EIA to sustainable Development. EIA in Project planning & Implementation, EIA process: Evaluation of proposed action, Scoping, EIA methodologies. Role of GIS in EIA baseline studies. Risk Assessment and Risk Management: Mitigation measures, comparison of alternatives, Reviews and decision making, compensatory actions, EIA notifications/regulations in India, Green belts: Review of Procedure, Practices and guidelines in India. EIA vs. SEA, Carrying capacity, Cumulative Impact assessment.	20	1
II	**Case Studies on EIA** EIA of (a) River valley Projects, (b) Thermal Power Plants, (c) Mining Projects, (d) Integrated Iron and Steel Industries, (e) Cement Industries, (f) Oil Refineries and Petrochemicals, (g)Tourism, (h)Coastal zone Development.	17	2

III	**Environmental Audit** Concept of Environmental Audit, Objectives of Audit, Types of Audit, Audit methodology, Features of effective auditing, Elements of audit process, Program Planning, Organization of auditing Program, Pre-visit data collection, Audit Protocol, On site audit: Data sampling, Inspection, Evaluation and Presentation, Audit report, Action Plan, Management of audit, Waster audits and pollution prevention assessment, Liability audit and site assessment, auditing of EMS, SWOT Analysis (Strength, Weakness, Opportunities and Threats analysis) for EIA, Audit Assessing, Economic & Environmental benefits direct from Environmental Audit, Life Cycle Assessment	20	3
IV	**Environmental Management System Standards** Core elements of EMS, Benefits of EMS, Certification Body Assessment of EMS, Documentation for EMS, EMS standard (ISO9000 & 14000 series): evolution, principles and structure, supporting systems, EMS specification standards & Certification procedures, EMS specification standards:ISO14001, Benefits of Implementing ISO 14001: Indian scenario.	18	4

Books and references:

1. Environmental Impact Assessment: Canter, L.W. 1977. Mc Graw Hill, New York
2. Environmental Impact Assessment Methodologies: Anjaneyulu Y. and Minickam V., BS Publications, Hyderabad
3. Manual of Environmental Impact Evaluation-Rosen JJ 1976 Prentice Hall
4. A practical guide to Environmental Impact Assessment, Erickson, P.A., Academic Press
5. Environmental Impact Analysis Hand book Rao & Woolen (eds) 1980 Mc Graw Hill
6. Environmental Quality Management: Bindu N Lohani 1984, South Asia Publ.
7. Environmental Impact Assessment: Alan Gilpin 1995, Cambridge Univ. Press
8. Manual of Environmental Impact Evaluation-Sharma, J. Rosen. Prentice Hall
9. Current documents on guidelines of EIA, MOEF, Govt. of India.
10. Strategic Environmental Assessment. R. Therirvel, E. Wilson, S. Thampson, D. Heany & D. Pritchard.
11. Environmental Impact Assessment- Cutting edge by 21st century- Cutting edge by Alan Gilpin, Cup, London

	Online				10.05.2024	10/5/24		10/05/2024		**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

12. Environmental Impact Assessment & Practice- Theory, P. Wathem, U. Hynman, Sydney
13. A Practical Guide to Environmental Impact Assessment – Paul A Erickson Academic Press
14 Planning and Implementation of ISO 14001, Environmental Management system-Gyani & Amit Lunia, Girdhar Raj Publ, House Jaipur.
15. A guide to the implementation of the ISO 14000 series on Environmental Management- Ritchie I and Hayes co Prentic Hall, New Delhi .
16. Environmental Management, Kulkarni, V. and Ramachandra, T.V., TERI press, New Delhi, 2009
17. Uberoi, N.K. (2010). Environmental Management, Excel Books, New Delhi.
18. ISO 14004 – Environmental management systems : General guidelines on principles, systems and supporting techniques (ISO 14004 : 1996 (E)).
19. Environmental management systems : Specification with guidance for use (ISO 14001 : 1996b (E)). (International organization for standardization – Switzerland).
20. Handbook of environmental management and technology : Gwendolyn Holmes, Ben Ramnarine Singh, Louis Theodore.
21. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication, New York.

	Online				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	IV
Course Code	Course Title		Course Type
ENV402	**ENVIRONMENTAL LAW, POLICIES AND SOCIETY**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced algebraic concepts, particularly in groups and field theory, and empower them to apply this knowledge to Understanding judicial response to environmental issues in India. - Knowing about importance of public participation through Right to information, Public Interest Litigation and other remedies in preserving and protecting environment.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Learn the laws and policies related to environment. They will understand the power, function and responsibilities of central board and state board with respect to the environment	Ap
2	Understand and interpret the structure of environmental laws as well as judgments of appellate courts in cases pertaining to the environment. Explain concepts that are central to environmental governance, including participation, common property resources and decentralisation.	Ap
3	It addresses a myriad of issues, including air and water quality, land use, wildlife protection, climate change mitigation, and waste management. By establishing legal mechanisms to manage human activities that impact the environment, it aims to strike a balance between economic progress and environmental protection.	U

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhari (Member)	Dr. Anand Kamavisdar (Member from DST)

4	They will learn the constitutional provisions in India, national and international trends. The goal of environmental law is to safeguard both the natural world and public health from the damaging impacts of human activity. This course is designed to provide knowledge and training to candidates to understand the legal aspects of environmental protection and legal measures to safeguard the natural resources.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	3	3	3	1	2	2	3
CO2	3	3	3	1	1	1	3	2	3	3	3	3	2	2	2	3
CO3	3	3	3	1	1	1	3	2	2	2	2	3	2	2	2	2
CO4	3	3	3	1	1	2	3	1	1	2	1	3	2	2	2	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Water, Air, Forest and Wildlife Act** Constitution of Central and State Pollution Control Boards, Power, Function and responsibility of Central and State Boards (Objectives, Area of jurisdiction, responsibility of an industry, power and function of state and central Government, Cognizance of offence, Penalties and Punishment), Brief account of The Forest Act 1927, Forest conservation Act. 1980: Objective and Jurisdiction, Responsibility of Industry. Wildlife Protection Act 1972.	25	1
II	**The Environment Protection Act 1986** Necessity and Scope of the Environmental Protection Act, Powers of the Central Government, Parallel Provisions with the water and the Air act, The Public Liability Insurance Act 1991, Biomedical waste (Handling and Disposal) rules 1998. Recycled plastic manufacture and usage rules 1999, Municipal Solid Waste (Management and Handling) Rules 2000, The Noise Pollution (Regulation and Control) Rules 2000, Environmental Impact Assessment Notification 2006, e-wastes Management and Handling Rules 2011	20	2

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

III	**Environmental Policies** Environment and constitutional provisions in India, National & International Trend. Changes in Global Prospective, Brief Note on Stockholm Conference 1972, Nairobi Declaration, Rio (Brazil) conference 1992, Kyoto Protocol, Johannesburg Conference 2002 National Authorities: Global environmental issues and international policies relating to control Global warming, Ozone depletion, hazardous waste, CITES etc.	24	3
IV	**Economics, Society and Environmental Ethics** Human impact on the Earth, Hunting and Gathering Society, Agriculture Society, Industrial Society, Sustainable -Earth Society: Concept of throw-away and sustainable -Earth Society, our future society; Environmental Ethics: Ethics and moral, ethics of Throw-away & Sustainable-Earth Society.	18	4

Books and References

1. Hand Book of Environment, Forest and Wild life laws in India, WPSI, Natraj
2. Pollution Control Acts, rules and Notifications issued under CPCB, New Delhi
3. Environmental Laws, New Perspectives, K. C. Agrawal, Nidhi Publisher, Bikaner
4. Wildlife of India, Conservation and Management, K. C. Agrawal, Nidhi Publisher
5. Environmental laws in India, Gurdip Singh, Quality Law Books
7. The Economics of the Environment, Oates W.E.
8. Kanchan Chopra, et al., Ecological Economics and Sustainable Development
9. Economy and the Environment, Goodstein
10. Sumi Krishna : Environmental Politics, Peoples' Lives and Developmental Choices, Sage, New Delhi, 1996
11. Cone J.D., Hayes S.C., Environmental Problems / Behavioral Solutions (1980) California
12. Declaration of The Stockholm Conference, Rio
13. Constitution of India [Referred articles from Part-III, Part-IV and Part-IV-A].

	Online				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	**Online**	**Online**
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	IV
Course Code	Course Title		Course Type
ENV403	**REMOTE SENSING & GIS**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of remote Sensing technologies & geographical information system, and empower them to apply this knowledge in image processing, land use and land cover mapping, and environmental resource studies.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Understand the remote sensing science & technology, interaction of energy with atmosphere and with earth surface features, interpretation of satellites and top sheet maps.	U
2	Students will understand the basic concept of remote sensing and know about the different types of platform, satellites, sensors & scanners, aerial photography, Indian scenario of remote sensing.	Ap
3	Student will understand the concept of digital image processing and learn about the visual photo interpretation techniques, image enhancement and restoration.	Ap
4	Understand the basic concept of GIS and its application, and learn about the GIS system hardware, software & infrastructure, and different types of data representation in GIS.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Online	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	2	2	3	1	1	2	3	3	1	2	2	3
CO2	3	3	3	3	2	1	3	-	-	2	2	3	2	1	2	3
CO3	3	3	3	3	2	2	3	1	1	2	2	3	2	2	3	2
CO4	3	3	3	3	2	3	3	1	2	2	3	3	2	2	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Introduction to Remote sensing Science & Technology** Introduction to Remote sensing Science & Technology: Principles of Remote sensing, Physical basis of Remote sensing. The nature and generation of Electromagnetic radiation (EMR). Interaction of EMR with the atmosphere and earth's surface features. Spectral signatures and characteristic spectral reflectance curves for rocks, soil, vegetation and water. Spectral quantities. Far and near infrared and microwave remote sensing.	15	1
II	**Remote Sensing Observation and Platforms** Remote Sensing Observation and Platforms: Air borne and space borne platforms, their relative importance and applications, Orbital geometry. Remote Sensing Satellites. Sensors, Aerial cameras and type of aerial photography, Photo scale and photo elements, Single and multiband scanners MSS sensor and other type of sensors. Aerial Stereo coverage and. Details of sensors on board. Hyperspectral imaging, RADAR and LIDAR techniques, Indian scenario of remote sensing.	20	2
III	**Introduction to Digital Image Processing** Digital image processing: Introduction to digital structure and data recording format sets. Visual Photo-Interpretation Techniques based on Photo elements and Terrain elements, Image Restoration, Enhancement and classifications, Significance of Ground Truths and Training Sets in Image Processing and in automated processing.	15	3
IV	**Principle of Geographic Information System** Geographic information system: Introduction, Definition and Terminology, Map Protection and Coordinate system, GIS	25	4

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
Online										Online	Online

	system hardware, software and infrastructures. Basic components of GIS software. Data structures. Data models, Data acquisition, Data Input and Data processing and management including topology, TIN model, DEM/DTM generation, overlying and Integration and final data product and report generation Integration of Remote sensing and GIS techniques and its applications in land use/land cover and Environmental resource studies.		

Books and references

1. Remote Sensing and GIS, Angi Reddy, The Books Syndicate, Hyderabad, 2000
2. Principles of Geographical Information Systems- P. A Burrough and R. A. Mc Donnel, OUP, Oxford, 1998.
3. Remote sensing for Earth Resource-Rao, D. P., AEG Publication, Hyderabad, 1987.
4. Geographical Information System-Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2002
5. Remote Sensing and Its Application –LRA Narayan University Press
6. Remote Sensing and GIS- Basudeb Bhatta Oxford University Press, 09-Oct-2011 - 752 pages
7. Remote Sensing of the environment, John R. Jensen, Dorling Kindersley India, Pvt. Ltd. 2009 - 592 pages
8. Remote sensing and image interpretation, Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman

Prof. Kamlesh. K. Shrivas, Chairman	**Online**	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	IV
Course Code	Course Title		Course Type
ENV404	**ENVIRONMENTAL DISASTER AND RISK**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced concepts related to the environmental disasters, particularly in groups and field theory, and empower them to apply this knowledge to solve Environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Students will able to understand Difference between hazard risk and disaster, its cycle and prediction, its mitigation technique etc. Understand the natural environment and its relationships with human activities	Ap
2	Earthquake, volcanoes and its different zones, its prediction and mitigation techniques and other mass movements like landslide rock fall etc.	Ap
3	Characterize and analyze human impacts on the environment. Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems	U
4	Develop a deep understanding of disaster resilience, risk mitigation, and recovery policies as they arise from natural hazards around the globe.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	2	-	-	3	1	-	-	-
CO2	3	3	3	1	1	1	3	2	-	-	-	3	2	-	-	3
CO3	3	3	3	1	1	1	3	2	-	2	-	3	2	-	-	2
CO4	3	3	3	1	1	2	3	1	-	2	1	3	2	-	-	-

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Hazard, Risk and Disaster** Hazard in the Environment, the concepts of hazard, risk and disaster, Human vulnerability to hazard, Disaster trends, complexity in hazard and disaster, Hazard zoning and risk assessment, Environmental Security and Hazards Zoning, hazard zoning maps & preparedness plan. Risk Assessment management: Disaster management cycle, Hazards vs. Risk, Evaluation of Risk, Strategies for Hazard Mitigation: Priorities, Prediction, warning & Public information, Minimizing the probability of hazards, Public policy for hazard management.	17	1
II	**Earthquakes, Volcanic and Mass movement Hazards** Origin of Earthquake, its magnitude and intensity, Earthquake prone zones in the Earth, Reservoir induced seismicity, effects of earthquake, stability of structure & Risk Assessment, coping with seismic hazards, seismic zoning map, seism tectonic map, earthquake prediction & control. Types of volcanic eruptions, Active volcanic belts in the world, nature and magnitude of volcanic hazards, prediction of volcanic eruptions, mitigation of volcanic hazards. Mass movement hazards: Landslides, Rock fall, snow avalanche hazards with some case studies.	19	2
III	**Floods, Cyclones, Tornados and Tsunamis** Floods and flood management, causes of excess flows, reduced carrying capacity of rivers, Runoff versus infiltration, sediment load & changing course of rivers, management of floods strategy, treatment of watersheds, reservoir &detention basis, water spreading, ground water recharge, stream channelization,	19	3

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

	flood embankments, flood plain zoning, flood forecasting & warning. Regions of flood prone zones in India. Origin of cyclones, tornados and tsunamis, their severity and impacts, coastal hazards mitigation measures.		
IV	**Technological hazards: Nature and Definition of Technological Hazards** Concepts of industrial pollution, nuclear radiation, toxic wastes, dam failures, transport accidents, factory explosions, fires, chemical spills, and technological hazards as a result of the impacts of a natural hazard. The growth of industrial hazard, Some case studies of Technological Disasters like Bhopal gas Tragedy 3 December, 1984, Chernobyl Nuclear accident 1986, Minnamata Japan, Japan's earthquake- tsunami- Fukushima nuclear disaster: 2011	20	4

Books and references:

1. Environmental Hazards: assessing risk and reducing hazards, Smith, K. and Petley, D.N. Routledge publication, London.2009, p.383.
2. Atmosphere, weather and climate, a textbook on climatology, Siddhartha, K. Kisalaya Publications Pvt. Ltd. New Delhi, 2000, p. 511
3. Environmental Geology, Valdiya K.S., Tata Mc-Graw Hill, 1987, p.
4. Landslide risk assessment, Lee E.M. and Jones D.K.C., Thomas Telford, 2004, p. 454
5. Environmental Geoscience: interaction between Natural Systems and Man, Strahler, A.N. and S Trahler A.H., Hamilton Publishing Company, California, p.511.
6. The nature of the Environment, Goudie, A., Blackwell Publications, 2001, p.544.
7. Living with Risk: The Geography of Technological Hazards by Susan L. Cutter (Jun 15, 1993)
8. Technological Disasters, P.C. Sinha, Anmol Publications Pvt. Limited, 1998 - 516 pages
9. Earthquakes and Tsunamis in the Past: A Guide to Techniques in Historical Seismology, E. Guidoboni and John E. Ebel, Cambridge University Press, 2009.
10. Earth quakes: Bruce A. Bolt
11. Elementary Seismology: Charles F. Richter

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	IV
Course Code	Course Title		Course Type
ENV405	**RESEARCH PROJECT/DISSERTATION**		RESEARCH PROJECT
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	-	-	10

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced concepts, particularly in groups and field theory, and research empower them to apply this knowledge to solve environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Development of deeper understanding of concepts	Ap
2	Experiencing experimental procedures directly and Development of thinking skills (critical, quantitative and qualitative)	Ap
3	Development of data analysis skills and Development of communication skills, including those involved in working in groups	U
4	They will experience outdoor sampling methods and experimentation and Learn to Use equipment in public places	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

Online					10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	2	1	3	1	3	3	2
CO2	3	3	3	1	1	1	3	2	1	2	3	3	2	3	3	3
CO3	3	3	3	1	1	1	3	3	2	2	3	3	2	3	3	2
CO4	3	3	3	1	1	2	3	1	1	2	1	3	2	3	3	1

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	Review or case studies on detection, determination, mapping, sources and control of environmental contaminants.	150	1

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) SEMESTER-II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	II
Course Code	**Course Title**		**Course Type**
ENV501	**RESEARCH METHODOLOGY AND SCIENTIFIC REPORT FOR ENVIRONMENTAL SCIENCE**		Value added
Credit	**Hours Per Week (L-T-P)**		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The aim of this course is to make students proficient in understanding of advanced applications in biotechnology including bioremediation, phytoremediation, biotechnology for air & water pollution and solid waste management. Through this knowledge, they will develop a strong foundation in practical application of biotechnology to addresses environmental problems.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Explain the types & approaches of research and significance of formulating research questions, objectives and hypotheses. Explain the significance of formulating research questions, objectives and hypotheses & analyze factors affecting the research topic in research.	Ap
2	Explain methods and tools of data collection& describe the method of representation of raw data with its advantages.	An

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **An**-Analyze; **E**-Evaluate; **C**-Create).

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
						10.05.2024	10/5/24	10.5.24	10/05/2024	10/5/24	Online	Online

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	3	2	2	3	2	2	2	3	3	2	2	3	3
CO2	3	3	3	3	2	2	2	2	3	3	3	3	3	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	**Research Methodology for Environmental Science** Introduction to Research Methodology for Environmental Science, Objectives of Research, Types of Research, Research Approaches, Research Methods, Validity and Reliability of Research, Use of Statistics in Research, Defining the Research Problem, Factors affecting the Selection of the Topic, Selection of Topics and Formulating Research Questions, Criteria for Evaluating Research Questions, Conceptualizing a Topic, Factors affecting the Selection of Topics, Formulation of Objectives and Hypothesis, Research Design, Principles of Research Design, Types of Research Designs, Developing a Research Plan- Exploration, Description, Diagnosis and Experimentation.	15	1
II	**Data Collection and Data Management** Collection of Data, Primary & Secondary Data Collection Methods, Introduction to Data management, Frequency Distribution, Tabulation of Data, Diagrammatic Representation of Data, Bar Diagrams, Pie Diagram or Pie Chart, Pie Diagram or Pie Chart, Pictograms or Pictorial Diagrams, Statistical Maps or Cartograms, Graphical Presentation of Statistical Data, Statistical Analysis of Data.	15	2

Books & References

1. Dulal, H., Shah, K., Sapkota, C.
2. , Uma, G., & Kandel, B. (2013). Renewable energy diffusion in Asia: Can it happen without government support?. Energy Policy, 59, 301-311. doi: 10.1016/j.enpol.2013.03.040
3. Begum K.J. and Ahmed A. (2015). The Importance of Statistical Tools in Research Work. International Journal of Scientific and Innovative Mathematical Research. Volume 3, Issue 12, December 2015, PP 50-58
4. Ford E.D. (2000). Scientific Method for Ecological Research. Cambridge University Press. 560pp.
5. Bhatta, B. (2015) Remote Sensing and GIS, Second Ed., Oxford University Press, New Delhi, 716p.
6. Campbell, J.B. (2002) Introduction to Remote Sensing, Third Ed., Guilford Publications, New York, 620p.

Online										Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

7. Grosof, M. S. and Sardy, H. (1985). A research primer for the social and behavioural sciences. Orlando: FL: Academic Press.
8. Aldridge, A. and Levine, K. (2001). Surveying the Social World - Principles and Practice in Survey Research. Open University Press: Buckingham. Bryman, A. (2008).
9. Social Research Methods. 3rd Edition, Oxford University Press., New York. Cohen, L., Manion, L., and Morrison, K. (2007). Research Methods in Education. Routledge: London and New York

Prof. Kamlesh. K. Shrivas, Chairman	Online	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Online	Online
	Prof. P. K. Behera (External member									Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

M.Sc. (Environmental Science) SEMESTER-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV502	Environmental Toxicology		Value added
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced concepts, particularly in groups and field theory, and research empower them to apply this knowledge to solve environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Introducing Toxicology and its History, disciplines and importance of toxicology	Ap
2	Study of Translocation of Toxicity, Absorption, Distribution and Excretion of toxic substances	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO / CO	POs											PSO				
	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	2	1	3	1	3	3	2
CO2	3	3	3	1	1	1	3	2	1	2	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Online									Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
1	**Introducing Toxicology:** History, disciplines and importance of toxicology, Potency and Toxicity, Acute toxicity, chronic toxicity), Hazards, Risks, Benefit-to-risk-ratio, tolerance limits, Acceptable daily intake, Threshold value. Factors affecting toxicity : interaction between chemicals (synergistic, additive and antagonistic). Dose, Effect and response, Dose-response curves , & Dose effect relationships	15	1
2	**Translocation of Toxicity:** Absorption, Distribution and Excretion of toxic substances. Absorption: membrane permeability, mechanism of chemical transfer (passive transport, active transport, facilitated transport), absorption (Gastrointestinal, skin, lungs). Distribution: tissue affecting distributions and tissues retention. Excretion: Renal excretion, Biliary excretion and Gastrointestinal. Receptor Concept, Nature of receptors, Theory of toxicant receptor interaction, Mechanism of action of some Pesticides (organochlorine, carbamate and organophosphate) and heavy metals (lead, arsenic, mercury, cadmium and chromium)	15	2

Book Reference

1. Singh M. P. and Tewari D.N., Agro-forestry and Waste Land, Anmol Publication, 1996 Page 38 of 52
2. Dwivedi A.P., Agro-forestry - Principles and Practices Oxford and IHB, 1992 Suggested readings
3. Gadgil, M. and Guha, R., The use and abuse of Nature, Oxford University Press, 2002.
4. Singh, P.et al (eds.), Agro-forestry Systems for Sustainable Land Use, Science Publisher, 2000.
5. Wojtkowski, P. A., Theory and Practices of Agro-forestry Design, Science Publisher, 2004.
6. Wojtkowski, P.A., Agrocological Perspectives in Agronomy, Forestry and Agro-forestry, Science Publisher, 2004.

Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)
	Online									**Online**	**Online**

M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I
Course Code	Course Title		Course Type
ENV601	**AGRO-FORESTRY AND FOREST MANAGEMENT**		Value added
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced concepts, particularly in groups and field theory, and research empower them to apply this knowledge to solve environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Ability to demonstrate understanding of the role and importance of forest and agroforestry in livelihood development	Ap
2	Ability to comprehend the species composition and its functional response with respect to the prevailing micro- and macro environmental conditions.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO	Pos											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	2	1	3	1	3	3	2
CO2	3	3	3	1	1	1	3	2	1	2	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

Online									Online	Online
Prof. Kamlesh. K. Shrivas, Chairman	Prof. P. K. Behera (External member	Prof. Kallol K. Ghosh (member)	Prof. M. K. Deb (Member)	Prof. Shamsh Pervez (Member)	Dr. Karuna dubey (member)	Dr. Bhanushrre Gupta (Memebr)	Dr. Ajita Dixt (Member)	Shri H. Deshmukh (Member)	Shri B. L. Yadaw (Member)	Dr. Indrapal Karbhal (Member)	Dr. Anand Kamavisdar (Member from DST)

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	Agroforestry and socioeconomic aspects.	15	1
2	Microclimate of forest ecosystem, tree physiology, growth, forestation for waste land recovery, deforestation and its impact on environment, agricultural, horticultural, silvicultural ecosystem.	15	2

Book Reference

7. Singh M. P. and Tewari D.N., Agro-forestry and Waste Land, Anmol Publication, 1996 Page 38 of 52
8. Dwivedi A.P., Agro-forestry - Principles and Practices Oxford and IHB, 1992 Suggested readings
9. Gadgil, M. and Guha, R., The use and abuse of Nature, Oxford University Press, 2002.
10. Singh, P.et al (eds.), Agro-forestry Systems for Sustainable Land Use, Science Publisher, 2000.
11. Wojtkowski, P. A., Theory and Practices of Agro-forestry Design, Science Publisher, 2004.
12. Wojtkowski, P.A., Agrocological Perspectives in Agronomy, Forestry and Agro-forestry, Science Publisher, 2004.

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10/05/24	Online				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	Online	Online

M.Sc. (Environmental Science) Semester-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV602	**INDIAN KNOWLEDGE SYSTEM**		Value added
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	25	75

Learning Objective (LO):

The course aims to equip students with a deep understanding of advanced concepts, particularly in groups and field theory, and research empower them to apply this knowledge to solve environmental problems and engage with higher-level research.

Course Outcome (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Ability to demonstrate understanding the Origin of Environmental Science from Vedas.	Ap
2	Ability to demonstrate understanding the Sacred Ecology, Environment & Water Management in India.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** Analyze; **E**-Evaluate; **C**-Create).

CO-PO/PSO Mapping for the course:

PO	POs											PSO				
CO	1	2	3	4	5	6	7	8	9	10	11	1	2	3	4	5
CO1	3	3	3	2	1	2	3	1	3	2	1	3	1	3	3	2
CO2	3	3	3	1	1	1	3	2	1	2	3	3	2	3	3	3

"3" – Strong; "2" – Moderate; "1"- Low; "-" No Correlation

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	Online									Online	Online

DETAILED SYLLABUS

Unit No.	Topics	No. of Lectures	CO No.
I	Vedic Approach to Environment, Concept of The Earth `Prithvi', Concept of Water 'Apah', Concept of Air 'Vayu', Concept of Ether 'Akasha', Concept of Mind 'Manas', Animals and Birds, Plants and Herbs 'Oshadhi', Concept of Sacrifice 'Yajna', Co-ordination Between All Natural Powers,	15	1
2	Sacred Forest, Sacred Groves, Rainwater Harvesting System: *Vav, Kund, Talav*etc, Sacred Hills and Mountains, Forest Management, Urban Planning Agroforestry, Harappan and Traditional Water Management System and Communities Involved in Water Management	15	2

Book Reference

1. S.R.N. Murthy, *Vedic View of the Earth*, O.K. Printworld, New Delhi, 1997, p.12.
2. A.R. Panchamukhi, *Socio-economic Ideas in Ancient Indian Literature*, Rashtriya Sanskrit Sansthan, Delhi, 1998, p.467.
3. N.M. Kansara, *Agriculture and Animal Husbandry in the Vedas*, Nag Publishers Delhi, 1995, pp. 126-138.

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	Online									**Online**	**Online**