PT. RAVISHANKAR SHUKLA UNIVERSITY

RAIPUR - 492 010, CHHATTISGARH

CURRICULUM & SYLLABUS
(Based on CBCS & LOCF)

M.Sc. Environmental Science
Semester System

Session: 2025-27

Semester: I-IV

Session: 2025-27

Approved by Board of Studies : **Chemistry**

Dates : **15.05.2025**

Name of chairman : Prof. Kamlesh Kumar Shrivas

Name of Members :
: Prof. Kallol K. Ghosh (Head, SoS in Chemistry & (CBS)
: Prof. M. K. Deb (Head, SoS in Environmental Science)
: Prof. N. K. Karade (External Members, RTM university) JOINED ONLINE
: Prof. Shamsh Pervez
: Prof. M. K. Rai
: Dr. M. L. Satnami
: Dr. Bhanushree Gupta
: Dr. Ajita Dixit
: Shree Hemant Deshmukh
: Shree B. L. Yadav
: Dr. Indrapal Karbhal
: Dr. Shobhana Ramteke

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)
	Prof. P. K. Behera (External member									Online	Online

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.
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.
PO-3	**Problem Solving:** Applying their knowledge and problem-solving skills to tackle intricate scientific and real-world issues. 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**: Effectively communicate complex scientific concepts and research findings to both technical and non-technical audiences, using written reports, presentations, and teaching. 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.
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
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.
PO-9	**Ethics**: Maintain the highest ethical standards in research and professional conduct within the field of Environmental Science.
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.

Online					10.05.2024	10/5/24	10.5.24	10/05/2024		Online	Online
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PROGRAMME SPECIFIC OUTCOME (PSOs): At the end of the program the student will be able to:

PSO1	Comprehensive understanding of fundamental theoretical principles and practical aspects of environmental Science.
PSO2	Apply the knowledge of Environmental Science concepts in interdisciplinary fields and draw the inferences by finding appropriate solutions.
PSO3	Apply the analytical instruments and computation programs ensuring precision, efficiency, and innovation in scientific research, industry, healthcare, and education. 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.
PSO5	Qualify national and state-level examinations like GATE, NET, and SET can lead to career opportunities in academia, research, and related fields.

M.Sc. ENVIRONMENTAL SCIENCE

Specification of Course	Semester	No. of Courses	Credits
Core	I-IV	21	90
Elective	II	02	10
Total		23	100
Additional Courses (Qualifying in nature, for Student admitted in School of Studies only)			
Generic Elective	II-III	02	02
Indian Knowledge System	I	01	02
Internship**	II	01	02
Skill Enhancement (Value Added Courses)	III	01	02

**** Student should need give 60 hrs. duration for Internship during semester II (Experience certificate is needed for requirement of the credit).**

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M.Sc. Environmental Science

STRUCTURE OF THE SYLLABUS

Course Code	Course Nature	Course Tile	T/P	Hrs/ Week	Credits	Evaluation Total		
A	B	C	D		E	CIA	ESE	TOTAL
Semester-I (YEAR I)								
ENV101	CORE	Fundamentals of Ecology	**T**	**5**	**5**	**30**	**70**	**100**
ENV102	CORE	Renewable, Non-renewable and Perpetual Resources	**T**	**5**	**5**	**30**	**70**	**100**
ENV103	CORE	Solid & Hazardous Waste Management	**T**	**5**	**5**	**30**	**70**	**100**
ENV104	CORE	Instrumental Techniques & Analytical methods in Environmental Science	**T**	**5**	**5**	**30**	**70**	**100**
ENV105	CORE	Lab course-1	**P**	**10**	**3**	**30**	**70**	**100**
ENV106	CORE	Lab course -2	**P**	**10**	**2**	**30**	**70**	**100**
Semester-II (YEAR I)								
ENV201	CORE	Environmental Pollution and Control: Air and Water	**T**	**5**	**5**	**30**	**70**	**100**
ENV202	CORE	Meteorology and Climatology	**T**	**5**	**5**	**30**	**70**	**100**
ENV203	CORE	Environmental Geoscience	**T**	**5**	**5**	**30**	**70**	**100**
ENV204	ELECTIVE Subject Elective (Select any one)	Water and Wastewater Treatment Technologies	**T**	**5**	**5**	**30**	**70**	**100**
ENV205		Environmental Pollution and Control: Soil, Radiation and Noise	**T**	**5**	**5**	**30**	**70**	**100**
ENV206	CORE	Lab course -3	**P**	**10**	**3**	**30**	**70**	**100**
ENV207	CORE	Lab course -4	**P**	**10**	**2**	**30**	**70**	**100**
Semester-III (YEAR II)								
ENV301	CORE	Environmental Toxicology	**T**	**5**	**5**	**30**	**70**	**100**
ENV302	CORE	Environmental Microbiology	**T**	**5**	**5**	**30**	**70**	**100**
ENV303	CORE	Data Analysis in Environmental Science	**T**	**5**	**5**	**30**	**70**	**100**
ENV304	CORE	Environmental Biotechnology	**T**	**5**	**5**	**30**	**70**	**100**
ENV305	CORE	Lab course -5	**P**	**10**	**3**	**30**	**70**	**100**
ENV306	CORE	Lab course -6	**P**	**10**	**2**	**30**	**70**	**100**
Semester-IV (YEAR II)								
ENV401	CORE	EIA, EA and EMSS	**T**	**5**	**5**	**30**	**70**	**100**
ENV402	CORE	Environmental Law, Policies and Society	**T**	**5**	**5**	**30**	**70**	**100**
ENV403	CORE	Remote Sensing and GIS	**T**	**5**	**5**	**30**	**70**	**100**
ENV404	ELECTIVE Subject Elective	Environmental Disaster and Risk	**T**	**5**	**5**	**30**	**70**	**100**
ENV405		Environmental Economics and Sustainable Development	**T**	**5**	**5**	**30**	**70**	**100**

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	(Select any one)							
ENV406	CORE	Research Project/Dissertation	**P**	**10**	**5**	**60**	**140**	**200**

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	30	70	100
III	ENV502	Environmental Toxicology	T	2	2	30	70	100

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

The candidates who have joined the PG Programme in School of Studies (UniversityTeaching Department), shall undergo Skill Enhancement Course/Value Added Course (only qualifying in nature) in Semester I and Semester III.

Semester	Course Code	Course Title	Course Type (T/P)	Hrs/ Week	Credi ts	Marks		
						CIA	ESE	Total
I	ENV107	Indian Knowledge System	T	2	2	30	70	100
II	ENV208	Internship	P	60 hrs	2	Experience Certificate (To full the credits)		
III	ENV307	Agro-Forestry and Forest Management	T	2	2	30	70	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	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
ENV406	√	√	√	√	√	√	√	√	×	√	√	√	√	√	×	√
No. of courses mapping the PO/PSO	23	25	23	22	23	25	25	23	22	25	25	25	23	23	20	25

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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	30	70

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 and the importance of biodiversity and strategies for conservation and sustainable resources use.	U
2	Assess the efficiency of energy transfer between trophic levels and its impact on food webs	An
3	Interpret data related to energy flow and productivity in different ecosystems and analyze population data using ecological models (exponential and logistic growth)	Ap
4	Evaluate human impacts on natural successional processes and understand the roles of pioneer species, seral stages and climax communities.	E

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

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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; 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, Secondary production: concept of secondary production, Relationship of secondary production to net primary production, concept of free energy, Enthalpy and Entropy, Energy flow in ecosystem, Lindeman's Trophic-Dynamic concept, Energy flow models.	19	2
III	**POPULATION ECOLOGY** Biotic potential and natality, mortality, survivorship curves, life table, age structure, population growth forms, concept of carrying capacity, Life history strategies, r and k selection, extrinsic 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.	15	3

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	Online									Online	Online

IV	**BIOTIC COMMUNITY AND ECOLOGICAL SUCCESSION** Concept of habitat and niche, types of niches: spatial, trophic and hyper volume niche, 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). 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.
6. G. T. Miller, Living in the environment: An introduction to environmental science, Wadsworth Publishers, 1998.
7. J. Turk, Introduction to Environmental Studies**,** Saunders, 1980.
8. E. J. Kormondy, Concepts of ecology, Prentice Hall, 1996.
9. M. M. Saxena, Applied Environmental Biology, Agrobios, 1990.
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**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-
Maximum Marks	CIA		ESE
100	30		70

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	Understanding the 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	Understanding and Critical thinking about 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).

Online										Online	Online
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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, 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: type of biodiversity, global distribution of biodiversity, key stone species, dominant species, biodiversity hot spots, 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 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.	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

IV	**PERPETUAL & NON-RENEWABLE RESOURCES** 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, 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.	14	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.

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	I	I
Course Code	Course Title		Course Type
ENV103	**SOLID & HAZARDOUS WASTE MANAGEMENT**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-
Maximum Marks	CIA		ESE
100	30		70

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	**INTRODUCTION TO 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, Incineration of solid wastes. Disposal in landfills and sanitary landfills, Leachate and landfill gas, landfill remediation. Regulatory aspects of municipal solid waste management, Plastic waste management.	19	2
III	**HAZARDOUS WASTE MANAGEMENT** Hazardous waste definition. sources and characterization. Sampling and analysis of hazardous wastes –proximate analysis –Ultimate analysis– directed analysis, 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 reduction, fly ash bricks, Regulatory aspects of HWM/HWM rules.	15	3
IV	**BIOMEDICAL, RADIOACTIVE AND E-WASTE MANAGEMENT**	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)

	Biomedical waste 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, Global strategy, recycling.		

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.

	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	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	30		70

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

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	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, crystallization, decantation, demister (vapour), distillation, drying, elutriation, evaporation, leaching, liquid-liquid extraction, solid phase extraction, flotation, flocculation, filtration, reverse osmosis, dialysis (biochemistry) fractional distillation, fractional freezing, magnetic separation, precipitation, crystallization, sedimentation, sieving, stripping, sublimation, vapour-liquid separation, winnowing and zone refining.	19	3
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	15	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)

	analytical methods (i.e. gravimetric, volumetric and thermal methods); Automatic analytical methods and Hybrid analytical methods., nephelometry and turbidimetry.		

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.

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											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 COURSE-1**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	10

Maximum Marks	CIA	ESE
100	30	70

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).

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	3	3	2	3	1	3	2	3
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	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)
10/05/24	Online				10.05.2024	10/5/24	10.5.24	10/05/2024	10/05/24	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 COURSE -2**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	-	-	10

Maximum Marks	CIA	ESE
100	30	70

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										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

"

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)
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 – 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	30		70

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	Understanding about the sources, types, and chemical composition of air pollutants and their behavior in the atmosphere.	R
2	Understanding about the Water Pollution: Identify various sources and types of water pollutants, including point and non-point sources. Evaluate different water treatment technologies and pollution mitigation strategies for industrial, agricultural, and municipal sources.	U
3	Understanding about the Prevention and Control of Air Pollution: Propose integrated and sustainable solutions to air quality management challenges in industrial and urban settings. Apply methods for measuring and monitoring air pollutants, including sampling techniques and instrumentation.	Ap
4	Understanding about the Prevention and Control of Water Pollution: Interpret water quality standards and legal frameworks for pollution control at national and international levels.	Ap

CL: Cognitive Levels (**R**-Remember; **U**-Understanding; **Ap**-Apply; **A-** 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:

PO / CO	POs											PSO				
	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 (SO_x, NO_x,CO_2,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	**PREVENTION AND CONTROL OF AIR POLLUTION** Source-emission inventory, Air quality criteria, Air quality standards (Ambient and Emission Standards), Mixing height, Gaussian Plume Models, Lapse rate, 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)	15	2
3	**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.	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).	18	4

Books & References

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)

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	30	70

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	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

CO \ PO	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	**ATMOSPHERIC-OCEANS AND EARTH'S RADIATION BALANCE:** 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, Latitude and the radiation balance, 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, turbulence and diffusion. Scales of meteorology.	15	1
II	**THERMAL CIRCULATION IN EARTH'S 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, Local winds. The causes of ocean currents, Zones of convergence and upwelling, El Nino, ENSO, The Earth's heat balance, Seasons in India. Concept of Monsoon, proxy components helpful in the reconstruction of Indian monsoon, How the Meghalayan Age came into existence.	19	2
III	**ATMOSPHERIC ENERGY** 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
IV	**HUMAN IMPACT ON 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, Glacial ice, 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	19	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)

	pollutants and vice versa, Wind roses, concepts of climate change & its reasons and impacts		

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	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	II
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	30	70

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	Demonstrate an understanding of the Earth's spheres and explain the formation and classification of different types of rocks. Analyze earth's dynamic processes including plate tectonics, types of plates, isostasy, and the role of geomorphic agents in the formation of various landforms.	U
2	Explain the principles of environmental geochemistry, including the concepts of major, trace, and rare elements. Illustrate the functioning of biogeochemical cycles and interpret mineral stability diagrams and their influence on the chemistry of natural waters.	U
3	Describe the global water balance and the chemical composition of seawater. Apply concepts of hydrological forecasting, including frequency analysis and understanding the cyclical nature of hydrological phenomena.	Ap
4	Describe the occurrence and movement of groundwater using Darcy's Law and its generalization. Distinguish between different types of aquifers and interpret groundwater level data.	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, 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, 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** 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 (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:	16	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)

	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: Aquifer and its types; Confined and Unconfined aquifers; Properties of Aquifer, permeability, porosity. Groundwater occurrence & movement; Ground water levels and Environmental influences.	**20**	**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		**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	30	70

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 sources, environmental impacts, and health effects of major water pollutants.	U
2	Understand the principles and mechanisms of various water treatment processes including physical, chemical, and biological methods.	Ap
3	Understand the principles, mechanisms, and design considerations of key tertiary treatment processes such as filtration, nutrient removal, disinfection, membrane technologies, and advanced oxidation.	Ap
4	Understand the objectives and significance of tertiary (advanced) wastewater treatment in achieving regulatory and reuse standards	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	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** Quality of water (water, sewage and industrial wastewater), Impact of water pollutants on humans, plants and animals, various stages of water treatment flocculation and coagulation, 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, 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.	20	2
III	**Tertiary Treatment of Wastewater** Tertiary treatment- *Membrane separation Techniques:* Brief description of MF, UF, NF membranes. Membrane materials, Types of membranes – Plate & frame, tubular, hollow fibre, spiral wound membranes, application of membranes in various industrial applications., *electro chemical techniques*: 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.	20	3
IV	**Sewage and Industrial Wastewater Treatment and Disposal:** Introduction, importance of sewage, Characteristics of sewage, Sewage treatment and disposal: Grit chamber, Sedimentation	20	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)

	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).		

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**		**ELECTIVE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

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	Students will be able to understand the Municipal solid waste and its 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	Classify the sources and types of radioactive pollution, and describe their environmental and health impacts. Demonstrate knowledge of the safe handling and disposal methods of radioactive waste.	An
4	Identify major sources of noise pollution and explain their impact on human health and well-being. Propose and evaluate prevention and control measures for effective noise pollution management.	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:

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.	16	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.	18	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

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	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	II
Course Code	Course Title		Course Type
ENV206	**LAB COURSE -3**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	10

Maximum Marks	CIA	ESE
100	30	70

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).

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						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	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

Online										Online	Online
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M.Sc. (Environmental Science) Semester-II

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

Maximum Marks	CIA	ESE
100	30	70

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
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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	30		70

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	Evaluate chemical hazards and assess risks using concepts like benefit-to-risk ratio, tolerance limits, acceptable daily intake (ADI), and threshold values.	U
2	Interpret the effects of chemical interactions (synergistic, additive, and antagonistic) and environmental factors on toxicological responses.	U
3	Assess how physicochemical properties, routes of exposure, and exposure duration affect the behavior and impact of toxic substances.	An
4	Understanding of Toxicity Tests, Apply the principles of dose-response relationships (graded and quantal) and use statistical tools such as therapeutic index and margin of safety in evaluating toxic effects	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

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: 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-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)	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	15	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
3. Environmental Pollution and Toxicology: Ray Choudhury & Gupta, Today & Tomorrow Pub.
4. Toxicology, Omkar
5. Toxicology, Sood, Sarup and Sons

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	Online									Online	Online

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	30	70

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	Analyze the ecological roles of microorganisms as components of air, water, and soil environments. Identify the types of airborne microbes and explain their role in causing allergic disorders, including fungal and pollen allergens.	Ap
2	Microbial Culture, demonstrate techniques for the collection and enumeration of aeroallergens, including fungal spores and pollen. Perform bacteriological analysis of water, sewage, and wastewater to assess microbial quality and pollution indicators.	Ap
3	Understand the Control of Microorganisms by physical, Chemical and chemotherapeutic agents with the mode of action including various antibiotics.	U
4	Understand the role of microbes as biofertilizers and biopesticides in sustainable agriculture and their environmental significance. Assess the industrial and biotechnological applications of microbial metabolites in food, pharmaceutical, and chemical industries.	An

Online										Online	Online
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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.	15	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, multiplication and kinetics of growth) and microbial metabolism (aerobic, anaerobic, fermentative pathways)	18	2
III	**Control of Microorganisms** Physical agents (temperature, pressure, radiation), chemical agent (bactericidal 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	20	4

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	Online									Online	Online

	source of fuel, role of microbes in the synthesis of Alcohols, Antibiotics, Amino acids, vitamin productions and other organic acids.		

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.

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											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
ENV303	**DATA ANALYSIS IN ENVIRONMENTAL SCIENCE**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

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

CO \ PO	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.	16	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 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.	18	4

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Online										Online	Online

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	30	70

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

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)

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	**FUNDAMENTAL OF 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, Biosorption, biomineralisation & bioleaching, mechanisms of bioleaching, Bio indicators, Biomarkers and Biosensors in waste treatment.	17	1
II	**BIOREMEDIATION OF 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	15	2

Online Online Online

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	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.		
III	**BIOTECHNOLOGY FOR 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 ORGANIC 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
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

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

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 COURSE -5**		CORE
Credit	Hours Per Week (L-T-P)		
	L	T	P
3	-	-	10

Maximum Marks	CIA	ESE
100	30	70

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.

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)
	Prof. P. K. Behera (External member									Online	Online

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.**

M.Sc. (Environmental Science) Semester-III

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

Maximum Marks	CIA	ESE
100	30	70

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

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	To determine mean, median, standard deviation, relative standard deviation of weight box & 10 mini bottles.	40	1
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.**

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-IV

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

Maximum Marks	CIA	ESE
100	30	70

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
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)

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	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, 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, 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	15	3

	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		
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
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.

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-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	30	70

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 constitution, structure, powers, and functions of the Central and State Pollution Control Boards in India. Evaluate the role of these laws and regulatory bodies in the conservation of forests, wildlife, and the overall 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	Assess the impact of international environmental agreements on national policies and global cooperation. Discuss the national and international trends in environmental policy and sustainable development.	U
4	Analyze the challenges and prospects for developing a future society based on sustainability principles. Evaluate the ethical considerations involved in the transition from a throw-away culture to a sustainable lifestyle.	An

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

Online										Online	Online
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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, Penalties and Punishment), Brief account of The Forest Act 1927, Forest conservation Act. 1980, Wildlife Protection Act 1972.	20	1
II	**THE ENVIRONMENT PROTECTION ACT 1986** Necessity and Scope of the Environmental Protection Act, Powers of the Central Government, 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
III	**ENVIRONMENTAL POLICIES** Environment and constitutional provisions in India, National & International Trend. Brief Note on Stockholm Conference 1972, Nairobi Declaration, Rio (Brazil) conference 1992, Kyoto Protocol, Montral Protocol, Johannesburg Conference 2002, CITES, etc.	20	3
IV	**SOCIETY AND ENVIRONMENTAL ETHICS** Hunting and Gathering Society, Agriculture Society, Industrial Society, Sustainable -Earth Society: Concept of throw-away and	10	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)

	sustainable -Earth Society, our future society; Environmental Ethics: Ethics and moral, ethics of Throw-away & Sustainable-Earth Society.		

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		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	30	70

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	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	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 & 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	**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

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)

IV	**GEOGRAPHIC INFORMATION SYSTEM** Geographic information system: Introduction, Definition and Terminology, Map Projection and Coordinate system, GIS 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.	20	4

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

	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-IV

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

Maximum Marks	CIA	ESE
100	30	70

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	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)

	spreading, ground water recharge, stream channelization, 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** 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	15	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	**Environmental Economics & Sustainable Development**		**ELECTIVE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	5	-	-

Maximum Marks	CIA	ESE
100	30	70

Learning Objective (LO):

The course aims to a deep understanding about the Environmental Economics: functions & Application, properties & need of environmental economics, environmental conservation, SDG and Sustainable Habitat, GRIHA.

Course Outcomes (CO):

CO No.	Expected Course Outcomes At the end of the course, the students will be able to :	CL
1	Basic concept of economics and relationship between economic development and environment. Concept of Market demand and supply market failure externality and its types.	R
2	Understanding about application of utility, benefits and costs analysis, risk and uncertainty & its analysis, stakeholder behaviors, existence and Bequest values, Non-compliance fees, tax emissions, economic & environmental trends, welfare, economic policies.	U
3	Application of environmental economics to overcome current environmental problems and economic issues like poverty, population explosion, environmental degradation. Student will able to apply knowledge in conservation economics, CDM & CC, SBA, Green Building & GRIHA.	Ap
4	Evaluate the sustainable development goals with all aspects including origin, historical background, need, importance, application and current scenario with future aspects.	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	3	3	2	2	2	3	3	3	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	3	3	3	2	2	3	3	3	3	3	3	3	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	**FUNDAMENTAL OF ECONOMICS AND ENVIRONMENT** Economics and Environment concepts, role, scope and significance of environmental economics, natural environment, environmental ecology, Eco-Tourism, economics activities and the environment, the market economy, consumer behavior and demand, producer behavior and supply, consumer and producer surplus, efficiency and perfect competition, imperfect market, market failure and externalities- pecuniary, non-pecuniary or technological, consumption, monopoly and externality, externality and industrial output, approaches to environmental pollution, government policies. Economic growth, Gross National product and the quality of life: Sustainable-earth economy, Economics and Pollution control, Discount factor, Cost-benefit and cost effectiveness analysis	20	1
2	**METHOD AND APPLICATION OF ENVIRONMENTAL ECONOMICS** Method and Application of utility, benefits and costs analysis, concepts of risk and uncertainty, sensitivity analysis, risk analysis, stakeholder behaviors, existence and Bequest values, instruments for environmental control applications – non-compliance fees, tax emissions, economic and the environmental trends, economic growth and welfare, trade and the environment, policy implications.	15	2
3	**ENVIRONMENTAL ISSUES** Current issues and environmental problems: poverty, population and the environment, environmental degradation in developing countries, biodiversity losses, resource conservation economics of conservation, limits to growth, ecological economics, thermodynamics and the environment, waste recycling, India's development in an ecological perspective, Carbon sequestration and carbon credits, Swachha Bharat Abhiyan. Sustainable Habitat: Green Building, GRIHA Rating Norms.	17	3
4	**CONCEPT AND STRATEGIES OF SUSTAINABLE DEVELOPMENT** The Sustainable development goals (SDGs) to transform our world: No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation and Infrastructure, Reduced Inequality, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace and Justice Strong Institutions, Partnerships to achieve the Goal.	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)

Books & References

1. Hussell, A., Principles of Environmental Economics, Routledge
2. Faber, M & Manstelton, R, 1996, Ecological Economics, Edward Elger Pub.
3. Pearce, D.W & Turner, RK, Economics of Natural Resources & Environment, Harvester
4. Dasgupta, P. & Maler, K., 1998, Environmental & Developmental issues, Basil Blackwell.

M.Sc. (Environmental Science) Semester-IV

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	IV
Course Code	Course Title		Course Type
ENV406	**RESEARCH PROJECT/DISSERTATION**		**CORE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
5	-	-	10

Maximum Marks	CIA	ESE
200	60	140

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).

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	Assessment of Environmental Pollution related to Air and Water Heavy metal pollution in urban soils, Noise pollution, Water quality assessment of rivers, ponds, waste water.	120	1
II	Bioremediation and Phytoremediation for industrial waste and organic waste management, Assessment of solid waste management.		2
III	Mapping of different forest cover, water resources and biodiversity using software, Monitoring Land Use and Land cover, Deforestation and Forest degradation change using remote sensing and GIS etc.		3
IV	Characterization of Organic aerosols and Inorganic aerosols, VOCs, SOA and their interpretation etc.		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)

Value Added Courses:
(Offered to the PG students of SoS in Environmental Science)
M.Sc. (Environmental Science) Semester-I

Program	Subject	Year	Semester
M.Sc.	Environmental Science	I	I
Course Code	Course Title		Course Type
ENV107	**INDIAN KNOWLEDGE SYSTEM**		Value added course
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	30	70

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).

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	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

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.

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	1	II
Course Code	**Course Title**		**Course Type**
ENV208	**Internship**		**Value added course**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2		-	60 Hrs
Maximum Marks	CIA		ESE

INTERNSHIP:-

During their internship at a university, research institute, or industry, Environmental Science students can gain valuable experience across a variety of practical and research-oriented topics. They may engage in environmental quality monitoring, including sampling and analysis of air, water, and soil to assess pollution levels. Interns often participate in laboratory-based experiments and fieldwork related to ecosystem studies, biodiversity assessment, and conservation practices. In research institutes, students may be involved in ongoing projects such as climate change modelling, and environmental impact assessments (EIA), helping them understand policy frameworks and mitigation strategies. Industry-based internships may expose students to waste management systems, wastewater treatment technologies, and industrial pollution control methods. They may also learn about environmental compliance standards, sustainability audits, and ISO certifications. Experience with GIS and remote sensing tools for environmental mapping and analysis is often a key component, along with exposure to renewable energy technologies and green chemistry applications. These experiences help students build technical skills, understand real-world environmental challenges, and contribute to sustainable development initiatives.

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

M.Sc. (Environmental Science) Semester-II

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV307	**AGRO-FORESTRY AND FOREST MANAGEMENT**		Value added
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-

Maximum Marks	CIA	ESE
100	30	70

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 / 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

DETAILED SYLLABUS

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)

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

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.

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**		**GENERIC ELECTIVE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-
Maximum Marks	CIA		ESE
100	30		70

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	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).

	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	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. 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
2. 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
3. Ford E.D. (2000). Scientific Method for Ecological Research. Cambridge University Press. 560pp.
4. Bhatta, B. (2015) Remote Sensing and GIS, Second Ed., Oxford University Press, New Delhi, 716p.
5. Campbell, J.B. (2002) Introduction to Remote Sensing, Third Ed., Guilford Publications, New York, 620p.
6. Grosof, M. S. and Sardy, H. (1985). A research primer for the social and behavioural sciences. Orlando: FL: Academic Press.

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

7. Aldridge, A. and Levine, K. (2001). Surveying the Social World - Principles and Practice in Survey Research. Open University Press: Buckingham. Bryman, A. (2008).
8. 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

	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-III

Program	Subject	Year	Semester
M.Sc.	Environmental Science	II	III
Course Code	Course Title		Course Type
ENV502	**Environmental Toxicology**		**GENERIC ELECTIVE**
Credit	Hours Per Week (L-T-P)		
	L	T	P
2	2	-	-
Maximum Marks	CIA		ESE
100	30		70

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					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)

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