Sant Gadge Baba Amravati University, Amravati
FACULTY: Science and Technology
Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Environmental Science following Three Years UG Programme w.e.f. 2023-24
(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option
M.S c . Environmental Science First Year Semester- I

S. N.	Subject	Type of Course	SubjectCode	Teaching & Learning Scheme							DurationOf ExamHours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practica l	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
0	*Pre-Requisite Course(s) if applicable/MOOC/Internship/Field Work cumulatively If students wish to opt Minor Course ofUG as Major for PG, balance 12 Credits Course will have to be completed (As and when applicable)	Th-Prq	100	0	0	0	0	Additional Credits to be earned = (1) minus (2) (1). Credits from Major DSC Courses in UG (minus) (2) The Credits already earned from the Course as Minor at UG, now to be opted as Major at PG			2	15	35			50	06	14	P
1	Research Methodology and IPR (FSC-RM)*	Th-Faculty Specific Core		4			4	4		4	3	30	70			100	12	28	P
2	DSC-I.1 (Environmental Science- An Interdisciplinary Approach)	Th-Major	EVS-101	4			4	4		4	3	30	70			100	12	28	P
3	DSC-II.1 (Geodynamics and Energy Resources)	Th-Major	EVS-102	4			4	4		4	3	30	70			100	12	28	P
4	DSC-III.1 (Concept of Ecology and Biodiversity)	Th-Major	EVS-103	3			3	3		3	3	30	70			100	12	28	P
5	DSE-I/MOOC	Th-Major		3			3	3		3	3	30	70			100	12	28	P
	DSE-I Land and Soil Conservation and Management		EVS-104.1																
	DSE-II- Environmental Pollution & Health		EVS-104.2														Minimum Passing Marks		Grade
6	DSC-I.1& II.1 Lab (Environmental Science- An Interdisciplinary Approach)		EVS-105 PR I			2	2		1	1	3			25	25	50	25		P
7	DSC-II Lab (Geodynamics and Energy Resources)		EVS-105 PR I			2	2		1	1	3			25	25	50	25		P
8	DSC-III Lab (Concept of Ecology and Biodiversity)		EVS-106 PR II			2	2		1	1	3			25	25	50	25		P
9	DSE-I Laboratory/MOOC Lab(	Pr-Major	EVS-107 PR III			2	2		1	1	3			25	25	50	25		P
10	# On Job Training, Internship/ Apprenticeship; Field projects Related to Major @ during vacations cumulatively	Related toDSC		120 Hours cumulatively during vacations of Semester Iand Semester II						4*									P*
11	Co-curricular Courses: Health andwellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV	Generic Optional		90 Hours Cumulatively From Sem I to Sem IV															
	TOTAL									22						600+50*			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory : Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note : # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

Sant Gadge Baba Amravati University, Amravati
FACULTY: Science and Technology
Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Science in the Programme Environmental Science following Three Years PG Programme w.e.f. 2023-24
(Two Years- Four Semesters Master's Degree Programme- NEPv23 with Exit and Entry Option
M. S c . Environmental Science P a r t I Semester- II [Level 6.0]

S. N.	Subject	Type of Course	SubjectCode	Teaching & Learning Scheme							DurationOf Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory +MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC-IV.2 Environmental Microbiology	Th-Major	EVS-201	4			4	4		4	3	30	70			100	12	28	P
2	DSC-V.2 Air and Noise Pollution	Th-Major	EVS-202	4			4	4		4	3	30	70			100	12	28	P
3	DSC-VI.2 Water Pollution	Th-Major	EVS-203	3			3	3		3	3	30	70			100	12	28	P
4	D S E - I I / M O O C	Th-Major		3			3	3		3	3	30	70			100	12	28	P
	DSE – III Natural Hazards and Disaster Management		EVS-204.1																
	DSE – IV Energy resources and sustainable development		EVS-204.2																
																	Minimum PassingMarks		
5	DSC-IV Lab Environmental Microbiology	Pr-Major	EVS-205 PR IV			2	2		1	1	3			25	25	50	25		P
6	DSC-V Lab Air and Noise Pollution		EVS-206 PR V			2	2		1	1	3			25	25	50	25		P
7	DSC-VI Lab Water Pollution		EVS-207 PR VI			2	2		1	1	3			25	25	50	25		P
8	DSE-II Laboratory/MOOC Lab	Pr-Major	EVS-207 PR VI			2	2		1	1	3			25	25	50	25		P
9	# On Job Training, Internship/ Apprenticeship; Field projects Related to Major @ during vacations cumulatively	Related to Major		120 Hours cumulatively during vacations of Semester I and Semester II						4*									P*
10	Co-curricular Courses: Health and wellness, Yoga Education, Sports andFitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV	Generic Optional		90 Hours Cumulatively From Sem I to Sem IV															
				Exit Option with a PG Diploma with 4 Credits On-the-job training/internship in the respective Major subject • Student has to earn Total minimum 4 Credits cumulatively during Vacations of Semester I and Semester II from internship in order to exit after First Year with PG Diploma (42-44 Credits) after Three Year UG Degree															
	TOTAL									18+4*						550			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: Prq, Theory: Th, Practical/Practicum: Pr, Faculty Specific Core: FSC, Discipline Specific Core: DSC, Discipline Specific Elective: DSE, Laboratory: Lab, OJT: On Job Training: Internship/ Apprenticeship; Field projects: FP; RM: Research Methodology; Research Project: RP, Co-curricular Courses: CC

Note: # On Job Training, Internship/ Apprenticeship; Field projects Related to Major (During vacations of Semester I and Semester II) for duration of 120 hours mandatory to all the students, to be completed during vacations of Semester I and/or II. This will carry 4 Credits for learning of 120 hours. Its credits and grades will be reflected in Semester II credit grade report.

Note: Co-curricular Courses: In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/

Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.

Sant Gadge Baba Amravati University Amravati

FACULTY : Science and Technology

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Environmental Science ------( ) following Three Years UG Programme wef 2023-24

(Two Years- Four Semesters Master's Degree Programme- NEPv23 with **Exit and Entry Option**

M. Sc. Environmental Science Second Year Semester- III

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory+ MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	Contemporary Applied Technological Advancements in Research relevant/supportive to Major DSC-I.3	**Th-Major**		4			4	4		4	3	30	70			100	12	28	P
2	DSC-II.3	**Th-Major**		4			4	4		4	3	30	70			100	12	28	P
2	DSC-III.3	**Th-Major**		3			3	3		3	3	30	70			100	12	28	P
3	DSE-III /MOOC	**Th-Major Elective**		3			3	3		3	3	30	70			100	12	28	P
																	Minimum Passing Marks		
4	DSC-I.3 Lab/Pr	**Pr-Major**				2	2		1	1	3			25	25	50	25		P
5	DSC-II.3 Lab	**Pr-Major**				2	2		1	1	3			25	25	50	25		P
5	DSC-III.3 Lab	**Pr-Major**				2	2		1	1	3			25	25	50	25		P
6	DSE-III Lab /MOOC Lab	**Pr-Major Elective**				2	2		1	1	3			25	25	50	25		P
7	**Research Project Phase-I**	**Major**			2	4	6	2	2	4				50	--	50	25		P
8	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV**	Generic **Optional**		**90 Hours Cumulatively From Sem I to Sem IV**															
	TOTAL									22						500			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology; Research Project: **RP, Co-curricular Courses: CC**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

Sant Gadge Baba Amravati University, Amravati

FACULTY : Science and Technology

Scheme of Teaching, Learning, Examination & Evaluation leading to Two Years PG Degree Master of Environmental Science ------( ) following Three Years UG Programme wef 2023-24

(Two Years- Four Semesters Master's Degree Programme- NEPv23 with **Exit and Entry Option**

M. Sc. Environmental Science Second Year Semester- IV [Level 6.5]

S. N.	Subject	Type of Course	Subject Code	Teaching & Learning Scheme							Duration Of Exam Hours	Examination & Evaluation Scheme							
				Teaching Period Per Week				Credits				Maximum Marks					Minimum Passing		
												Theory		Practical		Total Marks			
				L	T	P	Total	L/T	Practical	Total		Theory Internal	Theory+ MCQ External	Internal	External		Marks Internal	Marks External	Grade
1	DSC-I.4	**Th-Major**		4			4	4		4	3	30	70			100	12	28	P
2	DSC-II.4	**Th-Major**		4			4	4		4	3	30	70			100	12	28	P
3	DSC- III.4	**Th-Major**		3			3	3		3	3	30	70			100	12	28	P
4	DSE-IV /MOOC	**Th-Major Elective**		3			3	3		3	3	30	70			100	12	28	P
																	Minimum Passing Marks		
5	DSC-I.4 Laboratory	**Pr-Major**				2	2		1	1	3			25	25	50	25		P
6	DSC-II.4 Laboratory	**Pr-Major**				2	2		1	1	3			25	25	50	25		P
7	DSC-III.4 Laboratory	**Pr-Major**				2	2		1	1	3			25	25	50	25		P
8	DSE-IV Laboratory/MOOC Lab	**Pr-Major Elective**				2	2		1	1	3			25	25	50	25		P
9	**Research Project Phase-II**	**Major**			2	8	10	2	4	6	3			75	75	150	75		P
10	**Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts During Semester I, II, III and IV**	Generic **Optional**		**90 Hours Cumulatively From Sem I to Sem IV**															
	TOTAL									24						600			

L: Lecture, T: Tutorial, P: Practical/Practicum

Pre-requisite Course mandatory if applicable: **Prq**, Theory : **Th**, Practical/Practicum: **Pr**, Faculty Specific Core: **FSC**, Discipline Specific Core: **DSC**, Discipline Specific Elective: **DSE**, Laboratory: **Lab**, **OJT:** On Job Training: Internship/ Apprenticeship; Field projects: **FP**; **RM:** Research Methodology; Research Project: **RP, Co-curricular Courses: CC**

Note: **Co-curricular Courses:** In addition to the above, CC also include but not limited to Academic activities like paper presentations in conferences, Aavishkar, start-ups, Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.). These can be completed cumulatively during **Semester I, II, III and IV. Its credits and grades will be reflected in semester IV credit grade report.**

Table: Comprehensive Credits distribution amongst the type of Courses over Two Years (Four Semesters) PG Programme and Minimum Credits to be earned forPG Degree [Master in Faculty ----------Major ----------]

Sr. No.	Type of Course		Total Credits Offered	Minimum Credits Required
1	MAJOR			
	i. DSC	56		56
	ii. DSE	16		16
	TOTAL		72	72
2	Research Methodology and IPR (Faculty Specific Core)	04	04	04
2	On Job Training, Internship/ Apprenticeship;Field projects Related to Major	04	04 for 120 Hours OJT/FP cum.	02 (Minimum 60 Hours OJT/FP is mandatory)
3	Research Project	10	10	10
	OPTIONAL			
4	Co-Curricular Courses (offline and/or online as applicable): Co-curricular Courses: Health and wellness, Yoga Education, Sports and Fitness, Cultural Activities, NSS/NCC, Fine/Applied/Visual/Performing Arts, CC also include but not limited to Academic activitieslike paper presentations in conferences, Aavishkar, start-ups,Hackathon, Quiz competitions, Article published, Participation in Summer school/ Winter School / Short term course, Scientific Surveys, Societal Surveys, Field Visits, Study tours, Industrial Visits, online/offline Courses on Yoga (Yoga for IQ development, Yoga for Ego development, Yoga for Anger Management, Yoga for Eyesight Improvement, Yoga for Physical Stamina, Yoga for Stress Management, etc.).		Limited to Maximum 03 only (For 90 Hours of CC cumulatively)	00
	TOTAL			
	TOTAL		93	88

Table A: Comprehensive Credit Distribution for CC

S. N.	Activities (offline/online as applicable)	Credits at Levels						Letter Grade
		College	University	State	Zone if exist	National	Internationalif exist	
1	Health and wellness, Yoga* Competitions *If a Course (online/offline) on Yoga is completed for 60 Hours, 2credits will be awarded to the student (1 Credit = 30 Hours)	1	2	3	4	5	6	P (Pass)
2	Unnat Bharat Abhiyan [UBA]	1	2	3	4	5	6	P (Pass)
3	Sports and fitness activities (see separate Table B)	1	1 / 2	2 / 3	3 / 4	4 / 5	5 / 6	P (Pass)
4	Cultural activities, Fine/Applied/Visual/Performing Arts	1	2	3	4	5	6	P (Pass)
5	N.S.S. activities Camps	1	2	3	4	5	6	P (Pass)
6	Academic activities like Research Paper/Article/Poster presentations, Aavishkar, start-up, Hackathon, Quiz competitions, other curricular, co-curricular activities, students exchange programme etc. Research Paper/Article published	1 --	2 1	3 2	4 -	5 4	6 6	P (Pass) P (Pass)
7	Participation in Summer school/ Winter School / Short term course (not less than 30 hours 1 or 2 weeks duration)(not less than 60 hours 2 or 3 weeks duration) Scientific Surveys, Societal Surveys Field Visits, Study tours, Industrial Visits,	2 Credits 4 Credits 2 Credits 1 Credit						P (Pass) P (Pass) P (Pass) P (Pass)
8	NCC Activities	As given in Table C						

Table B: Credit Distribution for Sports and Fitness

Sr. No.	Particulars of Sports Status (Individual/ Team)	Credits	Letter Grade
1	College Level Participation	1	P (Pass)
2	University Level Participation	1	P (Pass)
3	University Level Rank 1, 2, 3	2	P (Pass)
4	State Level Participation	2	P (Pass)
5	State Level Rank 1, 2, 3	3	P (Pass)
6	Zonal Level Participation	3	P (Pass)
7	Zonal Level Rank 1, 2, 3	4	P (Pass)
8	National Level Participation	4	P (Pass)
9	National Level Rank 1, 2, 3	5	P (Pass)
10	International Level Participation	5	P (Pass)
11	International Level 1,2,3	6	P (Pass)

Table C: Credit Distribution for NCC activities

Sr. No.	Particulars of NCC Activities	Credits	Letter Grade
1	Participation in NCC activities	1	P (Pass)
2	'B' Certificate obtained	2	P (Pass)
3	'C' Certificate obtained	3	P (Pass)
4	State Level Participation	4	P (Pass)
5	National level Participation	5	P (Pass)
6	International Level Participation	6	P (Pass)

Sant Gadge Baba Amravati University

Part A

Faculty – Science and Technology

Programme- M. Sc. (Environmental Science) (NEPv23)

NEP-2020

Program Objectives (POs):

After completion of this Programme successfully, students would be able to:

1. Acquire fundamental knowledge of different aspects of environment and local, regional and global environmental problems.
2. Develop environmental monitoring skills, including conduct of experiments and data analysis.
3. Apply systems concepts and methodologies to analyse and understand interactions between social and environmental processes.
4. Use environmental pollution control technologies.
5. Acquire the knowledge and skills needed for the environmental design and management.
6. Apply skills in the preparation, planning and implementation of environmental projects.
7. Develop ability to adopt changing scientific environment in the process of sustainable development by using statistical tools.

Programme Specific Objectives (PSOs):

After completion of this Programme successfully, students would be able to:

1. Apply the basic concepts of physical, chemical, mathematical, and biological sciences appropriately to the discipline of environmental science.
2. Use state-of-the-art techniques, tools and skills necessary for accurate analysis of environmental samples.
3. Demonstrate knowledge and understanding of the environmental principles and apply these to his own work, as member and/or leader in a team, to execute multidisciplinary projects.
4. Gain Advanced knowledge of fundamentals of Environmental Science with enhanced command over modern scientific methods, techniques and chemical processes equipped with environment safety measures.
5. Communicate complex technical information related to Environmental Science in a clear and concise written and verbal manner as oral presentations and compilation in the form of scientific reports.
6. Protect Natural Resources.

Employability Potential of the Programme:

The students passing M.Sc. Degree in the subject Environmental Science have the opportunity of job and services in the field of Teaching, Researches, Projects, Effluent Treatment Plants of various Industries/Companies/Factories, Municipal Councils/Corporations, Central Pollution Control Board, State Pollution Control Boards, National Research Institutes/Organizations/Laboratories, NEERI, EIA, GIS, Environmental Monitoring Projects,

Environmental Consultants, Different Laboratories, NGO's, Forest Department, Water Purification and Treatment Plants and Various Sectors related to the field of Environment.

In Government Sector-

- Environmental Scientist in Research Institutes
- Regional / Sub Regional Officer in Pollution Control Boards
- Pollution Control Officer in Corporation / Council
- Scientific Officer in MPCB/CPCB
- Professor at Universities and Senior Colleges
- Lecturer at Junior Colleges
- Technician in Ground water quality Analysis
- Technician in Health laboratories.
- Biodiversity board
- Air water and Soil quality testing

In Corporate Sector-

- Pollution Control Officer. • ETP Operator • Industrial Safety Officer. • Environment Manager.
- Designing and Operation on STP and ETP
- Expert / Entrepreneur
- Environment Impact assessment.
- Environmental Consultant.
- Environment Auditor
- ISO 14000 Certification
- Green and Energy Auditor
- Sustainability Consultant
- Forest Carbon Specialist
- Environmental Risk Modeler
- Senior Catastrophe Risk Modeller Environmental Journalism.
- Wildlife Filmmaker.
- Environmental Journalists.
- Environmental Photographer.

Others-

- 30% syllabus of Ecology and Environment in UPSC
- Data Scientist in Environmental Science
- Conservation Hydrologist
- Quality control officer in any industry
- Pharma industries and Waste and water sectors
- Sanitation and Swachh Bharat Mission Work in the projects like UNDP, UNICEF, BMGF, Disaster Management projects, waste water, solid waste management, Environment education.
- Marine Scientist

Part B

Syllabus Prescribed for **PG. Programme**

Programme: **M.Sc. Environmental Science**
(NEPv23)

Semester-I

Code of the Course Subject	Title of the Couse/ Subject	No. of periods/ week
EVS 100	**Research Methodology and IPR**	**04**

Course objectives:
After completion of this Course successfully, students would be able to:

1. To understand the role of research methodology in Engineering/Science/Pharmacy
2. To understand literature review process and formulation of a research problem
3. To understand data collection methods and basic instrumentation
4. To learn various statistical tools for data analysis
5. To learn technical writing and communication skills required for research
6. To create awareness about intellectual property rights and patents

Unit	Theory
Unit-I	**Introduction to Research:** Definition of research, Characteristics of research, Types of research- Descriptive *vs.* Analytical, Applied *vs.* Fundamental, Quantitative *vs.* Qualitative, Conceptual *vs.* Empirical, Overview of research methodology in various areas, Introduction to problem solving, basic research terminologysuch as proof, hypothesis, lemma etc., Role of Information and Communication Technology (ICT) in research
Unit-II	**Research Problem Formulation and Methods:** Literature review, sources of literature, various referencing procedures, maintain literature data using Endnote 2, Identifying the research areas from the literature review and research database, Problem formulation, Identifying variables to be studied, Determining the scope, Objectives, Limitations and or Assumptions of the identified research problem, Justify basis for assumption, Formulate time plan for achieving targeted problem solution. Important steps in research methods: Observation and Facts, Laws and Theories, Development of Models, Developing a research plan: Exploration, Description, Diagnosis and Experimentation
Unit-III	**Data collection:** Applied statistics: methods of data collection, Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis Software tools for modelling, Simulation and analysis.

	Analytical Environmental Data: Basic concept and definition, true result, error, types of error, accuracy, precision and standard deviation.
Unit-IV	**Static and dynamic characteristics of instruments:** calibration of various instruments, sampling methods, Basic Concepts concerning testing of hypotheses, procedures of hypothesis testing, generalization and interpretation
Unit-V	**Instrumental techniques in environmental analysis**: (principle, Instrumentation merits and demerits of techniques) colorimetry, spectrophotometry, atomic absorption spectrophotometry, flame photometry, gas chromatography, high performance liquid chromatography, ion exchange chromatography, high volume air sampler and polarography
Unit-VI	**Research Ethics, IPR and Publishing**: Ethics: Ethical issues. IPR: intellectual property rights and patent law, techniques of writing a Patent, filing procedure, technology transfer, copy right, royalty, trade related aspects of intellectual property rights Publishing: design of research paper, citation and acknowledgement, plagiarism tools, reproducibility and accountability.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Demonstrate the ability to choose methods appropriate to research aims and objectives.
2. Understand the limitations of particular research methods.
3. Develop skills in qualitative and quantitative data analysis and presentation

Reference Books:

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide or Beginners",SAGE Publications Ltd., 2011.
2. Wayne Goddard, Stuart Melville, "Research Methodology: An introduction"JUTA and Company Ltd, 2004.
3. C.R. Kothari, "Research Methodology: Methods and Trends", New Age International,2004
4. S.D. Sharma, "Operational Research", Kedar Nath Ram Nath & Co.,1972
5. B.L. Wadehra,"Law Relating to Patents, Trademarks, Copyright Designs and Geographical Indications", Universal Law Publishing, 2014.
6. Donald Cooper, Pamela Schindler, "Business Research Methods", McGraw-Hill publication, 2005.

Part B

Syllabus Prescribed for 2022 Year- **PG. Programme**

Programme- **M.Sc. Environmental Science**

Semester-I

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods / weeks
EVS 101	**Th/ Environmental Science- An Interdisciplinary Approach**	**04**

COs:

After completion of this Course successfully, students would be able to:

1. Appreciate the interaction between earth and atmosphere system, particularly the microclimate.
2. Get acquainted with different types resources and its distribution.
3. Create knowledge for sustainable exploration, usage and conservation of different types of mineral resources.
4. Explain why biological diversity is important, that is, nature's intrinsic and instrumental values.
5. Highlight the threats to biological diversity, that is, direct harvesting, habitat destruction, and introduction of non-native species, among others, and their interactions.
6. Know about the municipal solid waste and its various disposable methods and techniques.
7. Demonstrate sound understanding of the waste generation process and characteristics of different types of solid wastes.
8. Apply recycling vis-à-vis resource recovery technologies for useful conversion of specific waste type to eco-friendly products.

Unit	Theory
I	**Basic issues in environmental sciences:** Definition, principles and scope of environmental science, human population growth, urbanization, sustainability and carrying capacity, environmental attitudes of individuals, society.
II	**Earth as a system:** Environmental unity, earth and life, earth as an eco-system, mass and energy transfer across various interfaces, material balance, first and second law of thermodynamics, heat transfer process.

III	**Environmental geo-science and geo-chemistry:** Basic environmental problems, geo-science factors in environmental planning, Concept of plate tectonics, major plates and boundaries. Major trace elements and classification of trace elements, mobility of trace elements, biogeochemical factors in environmental health.
IV	**Urban environment, waste management and sustaining living resources:** City as a system, influence of city life on city planning and environment, concept of waste disposal.
V	**Minerals, environment and environmental economics:** Importance of minerals in environment, agriculture, industry and life, resources and reserves, Importance of environmental economics, cost benefit analysis (CBA), policy instruments.
VI	**Problems in Agriculture:** Effects of fertilizers on soil, pest control and agro-chemicals, integrated pest management, undesirable effects of irrigation on soil.

Learning outcomes:

After completing this course successfully, students would be able to

1. Explain the fundamentals of socio-environments aspects and problems.
2. Understand environmental systems.
3. Acquire knowledge about Geo-environmental aspects.
4. Illustrate and justify urban environmental systems and understand importance of minerals.

Recommended Books

Text Books:

1. Physical geography by Savindra Singh
2. Climatology by Savindra Singh.
3. Physical Geology by P.K. Mukharji.
4. A Text book of Ecology and Environment by P.C. Joshi and Namita Joshi, Himalaya.
5. Environmental Geography by Savendra Singh.
6. A Text Book of Marine Ecology by Balkrushnan Nair.
7. Environmental Biology by Verma and Agrawal.
8. Ecology and Environment by P.D. Sharma.

Reference Books:

1. Climatology by S.K. Lal
2. Ecology by Weiver and Climents
3. Engineering and general Geology by Parbin Singh
4. Environmental Science, Danial Botkin and Edward Keller. John Wiley and Sons, New York (1997).
5. Environmental Geology by K.S. Waldia.

6. Fundamentals of Ecology by E.P. Odum.
7. Environmental Sciences, Daniel Botkin and Edward Keller, John Wiley and Sons, New York (1997).
8. Environmental Science, Eldon D. Enger and Bradley F. Smith, WCB Publishers, Boston (1995).
9. Forests in India, Dr. A. K. Jain Vorha Publication, Allahabad (1989). N4. Advances 0f Environmental Science and Technology, Nileel1la.Rajvaidya APH Publishing House, Delhi (1989).
10. T.D. Bishwas & S. K. Mukharji, AJ.B. of Soil Sciences, Tata McgrawNhill pub. Co. Ltd. New Delhi. (II Edition 1997).

Syllabus prescribed for- **PG. Programme**

Programme: **M.Sc. Environmental Science**

SEMESTER-I

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods / weeks
EVS 102	**Geodynamics and Energy Resources**	**04**

COs:

After completion of this Course successfully, students would be able to:

1. Understand the principal and concepts of ecosystem dynamics and energy flow through ecosystems. Acquire knowledge about structure and functions of ecosystem.
2. Students also learn about the concept of Biomass.
3. Students can understand fundamental concept of environmental geology.
4. Students will gain the knowledge about geologic hazards & risks.
5. Identification of potential Ocean Hazards.
6. Identification of sources of energy and its use for sustainable development.
7. Understand conventional and non-conventional energy resources.
8. Acquire the knowledge about important of non-conventional energy resources and its type.

Unit	Theory
Unit-I	**Ecosystem dynamics:** Definition, kinds of ecosystems, fundamental concepts, structure and functions of ecosystem, energy flow through ecosystems: Ecological energetic, Carrying capacity.
Unit-II	**Biomass productivity:** Concepts of biomass, Food chains and food web, Ecological pyramids. Methods of measurement of biomass and primary productivity, Ecological efficiencies. Bioaccumulation and biomagnifications, Biotic Interaction.
Unit-III	**Geo-environment:** Introduction, fundamental concept of environmental geology. The concept of earth system, The rock cycles, Earth's thermal environment and seasons. Indian monsoon, El-Nino and La-Nina, droughts.
Unit-IV	**Geological hazards:** Assessing geologic hazards & risks, types of hazards - earth quakes, volcanic eruptions, floods, subsidence, landslides, soil erosion and desertification. Hazardous of ocean and weather- sea water intrusion, tsunami, tropical cyclones.
Unit- V	**Conventional energy resources and mechanism of utilization:** Sources of energy, Energy requirement, - wood, Coal. Oil and natural gas, nuclear energy.

Unit-VI	**Non-conventional energy resources:** Biogas energy, Ocean thermal energy, wind wave energy, tidal energy, Nuclear energy, Hydropower plant, wind energy, geothermal energy, energy from wastes Ecotechnology, Solar energy: Photovoltaic, solar cooker, solar water heater, Solar ponds. Energy from biomass, anaerobic digestion.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Acquire knowledge of how material, energy floes in to the ecosystems.
2. Apply their knowledge to measurement of ecosystem productivity.
3. Understand types of geological hazard and their possible, effects.
4. Demonstrate non-conventional energy resources.

Recommended Books:

1. Environmental Geology: K.S. Valdiya Indian. Context Tata Mcgraw Hill Pub. Co, New Delhi, 1987.
2. Environmental Geology: Barbara, Wim, Brain, J.S. Stephen, C.P. John Wiley & Sens. Inc.
3. Environmental Geology: Cundgran, Lawrence Prentice Hall.
4. Geology in Env. Planning: Howard, A.D., and Remson, McGraw. Hill, New York 1978.
5. Env. Geology: Kellev.Natural hazards: Alexander.
6. E. P. Odem (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.

Syllabus Prescribed for - **PG Programme**

Programme: **M. Sc. Environmental Science**

Semester I

Code of the Course/Subject	**(Laboratory/Practical/practicum/hands-on/Activity)**	**No. of Periods/Week**
EVS-105	**Practical based on DSC I.1 Environmental Science - An Interdisciplinary Approach and DSC II.1 Geodynamics and Energy Resources.**	**04**

Experiment No.	**Experiment**
1.	**To determine Productivity of Terrestrial Ecosystem.**
2	Exercises on satellite imagery/photo interpretation
3	Study of resource maps.
4	Study of seismic and flood-prone areas in India.
5	**Study properties of minerals and their Identification.**
6	Determination of energy contents of biomass.
7	Study of soil profile and determination of soil texture.
8	Identification of drainage patterns.
9	Determination productivity of terrestrial ecosystem.
10	Determination productivity of aquatic ecosystem.
11	Demonstration of non-conventional energy sources.
12	Natural Hazard Identification- Landslides, subsidence, flood, forest fires etc.
13	Study of local Monsoon pattern
14	To identify carbonate rocks by acid test.
15	To demonstrate the process of soil erosion.
16	To determine the biomass of a particular area.
17	To study the characteristics of different soils.
18	To determine energy properties of wood. (Density, Moisture content, Volatile matter, Percentage of fixed carbon, and Percentage of ash content).
19	Study of soil profile and determination of soil texture.

Learning Outcomes:

Upon completion of this Course successfully, students would be able to:

1. Determine ecosystem productivity.
2. Demonstrate interpretation of aerial photograph.
3. Assesse resource maps.
4. Identify type of minerals.
5. Estimate energy content in matter.

6. Classify layers in soil profile.
7. Demonstrate the soil texture.
8. Determine productivity of terrestrial and aquatic ecosystem.
9. Demonstrate non-conventional energy sources.
10. Identify natural hazards.
11. Demonstrate presence of carbonates in rocks.
12. Classify soil.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION

M.Sc. I (Environmental Science)

SEMESTER – I (NEP-20)

PRACTICAL I: Environmental Science- An Interdisciplinary Approach and Geodynamics and Energy Resources

Time: 6 Hours **Marks: 50 + 50= 100**

Practical External

Q.1. Exercises on satellite imagery/photo interpretation	10 Marks
Q.2. Exercises on Minerals and rocks	05 Marks
Q.3. Interpretation of Resource Map	10 Marks
Q.4. Determine energy properties of material.	10 Marks
Q.5. Demonstration of Carbonate content.	05 Marks
Q.6 Exercise on productivity of ecosystem.	10 Marks

Total Marks: 50

Practical Internal:

1. Record/ Assignments -	20 Marks
2. Viva Voce -	20 Marks
3. Attendance-	10 Marks

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50 Marks

Part B

Syllabus Prescribed for 2022-23 Year- **PG. Programme**

Programme - **M.Sc. Environmental Science**

SEMESTER-I

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods/weeks
EVS-103	**Concept of Ecology and Biodiversity**	**03**

COs:

After completing this course successfully, students would be able to:

1. Be proficient in ecological field methods such as wildlife survey, biodiversity assessment, mathematical modelling and monitoring of ecological systems.
2. Use interdisciplinary approaches such as ecology, economics, ethics and policy to devise solutions to environmental problems.
3. Understand the complex mechanism of ecological succession.
4. Analyse the basic concept of population ecology of surrounding.
5. Understand research methods used in ecological studies
6. Aware about emerging technologies in Ecological Research.

Unit	Content
I	**Introduction:** Definition, principles and scope of ecology, history of ecology, subdivisions of ecology, relation to other sciences, relevance to civilization, levels of organization types of ecology – synecology, autecology
II	**Population ecology:** Basic concepts of population ecology, population dynamics characteristic features: Natality Mortality, fecundity, density, age distribution, biotic potential, prey-predator relationship, Environmental resistance in relation to absolute maximum and realized minimum carrying capacity size and distribution of population. (Random, Aggregate and uniform populations)
III	**Ecological Succession and community Ecology:** Mechanism of succession; course of succession, trends of succession, climax concept in succession, models of succession. Characteristics of community, composition and structure, origin and development, ecotone, edge effect, ecological niche, interspecific and intra

	specific competition.
IV	**Biodiversity and its conservation:** Species, genetic and ecosystem diversity, levels of biodiversity, Importance and biodiversity indices, values of biodiversity,
V	**Biodiversity and threats:** Biodiversity hotspots, loss of biodiversity, convention on biological diversity, strategies for conservation of biodiversity.
VI	**Biodiversity Action Plan:** Ex-situ and In-situ conservation, Biodiversity legislation, Sustainable utilization. National Policy and measurement estimation of the biological biodiversity, diversity act 2002, Biological diversity rules, 2004.

Learning Outcomes:

Upon completion of this Course successfully, students would be able to:

1. Understand meaning history, types and their relevance to sciences of ecology.
2. Apply learning skill to identify relationship among levels in ecosystem.
3. Develop problem solving abilities in conservation of biodiversity.
4. Identify threats and strategies for conservation of biodiversity.

Text Books

1. Biodiversity and Environment: - S.K. Agarwal, S. Tiwari and P.s.Dubey, 1996.
2. Concept of Ecology: - E.J. Koromondy, 1996, Concept of modern Biology Series, Prentice Hall
3. Ecology and Environment: - P.D. Sharma, 1994.
4. Environmental Science: - Daniel Botkin and Edward Kelter, John Wiley and Sons, New York.
5. Environmental Science: - Eldon d. Enger and Bradley F. Smith, WCB Publishers; Boston.
6. Ecology 2000: - Sir Edmand Hillary.
7. Modern Concepts of Ecology: - H.D. Kumar.
8. Fundamentals of Ecology: - Dash M.C. Tata McGraw Hill. Pub. Co-Ltd. New Delhi.
9. Ecology and Environment: - P.W. Sharma Rastogi Publications,Meerut.
10. Principals of Environmental Biology: - P.K.G. Nair, Himalaya Pub.House, Delhi.
11. Environmental Science: - Enger, Smith, Smith W.M.C, Brown.Company Publication
12. Principles of Ecology – P.S. Verma, V.K. Agarwal, S. Chand and Co.Delhi.
13. Ecology – M.P. Arora
14. Concept of Ecology – E.J. Koromondy, 1996, concept of modernbiology series, prentice Hall.
15. Principles of Environmental Biology – P.K.G. Nair, Himalaya pub.House, Delhi
16. Basic concepts of soil science – A.K. Kolay, Willey estern ltd., NewDelhi.
17. Environmental Science – Enger, Smith, Smith, W.M.C. Browncompany publishing
18. Practical Method in Ecology – R.K. Trivedi, P.K. Goel and Trisal., Enviro Publication, Karad.
19. Fundamental of Ecology – Dash M.C. Tata McGraw Hill Pub. Co. Ltd. New Delhi.

20. Biodiversity and environment – S. K. Agarwal
21. Biodiversity measurement and estimation – D. L. Hawks

Reference Books:

1. The Biological diversity Act 2002 and Biological diversity rules 2004: - National Biodiversity Authority INDIA. 475, 9th South crossstreet, Kalpalocwar Nagar, Neelangarai Chennai – 600041.
2. Biodiversity Measurement and Estimation: - D.L. Hawks worth Director international Mycological Institute Surrey, UK, Published:-Chapman & Hall, Condou New York, Tokyo, Madras.
3. Fundamentals of Ecology: - E.P. Odum, Revised Edition 1995-96 Edition 2003.
4. Biodiversity Conservation: - Global agreements and national concerns RAMSAR sites CBD, Quarantine, Regulation, National terety policy Biodiversity Act wild life Act.
5. Principles of Environmental Science – Wart K.E.F. (1973) Mc GrawHill Book Company.
6. The Biological Diversity Act. 2002 and Biological Diversity rules 2004 – National Biodiversity Authority India. 475, 9th South cross street, Kalpalocwar Nagar, Neelangarai, Chennai – 600041.
7. Biodiversity conservation – Global agreements and national concerns. RAMSAR sites CBD, Quarantine, Regulation, NationalForestry policy, Biodiversity Act, Wild life protection Act,
8. Concepts of Ecology (Fourth Edition)- Edward J. Kormondy, Prentice Hall of India Pvt. Ltd. New Delhi.
9. Manual for field Ecology: - R. Mishra.

Syllabus Prescribed for - **PG Programme**

Programme: **M. Sc. Environmental Science**

Semester I

Code of the Course/Subject	**(Laboratory/Practical/hands-on/Activity)**	**No. of Periods/Week**
EVS-106	**Practical based on DSCI II.1 Concepts of Ecology and Biodiversity**	**02**

Experiment No.	**Experiments**
1	To study the biotic components of a Pond ecosystem.
2	To compare the biomass and net primary productivity of un-grazed and grazed grass land.
3	To study the abiotic and biotic components of a forest ecosystem.
4	To estimate the Net primary productivity by light and dark bottle method
5	To determine the minimum no. of quadrats to be laid down in the field under study.
6	To determine frequency, density and abundance of a species of a given natural stand.
7	To study frequency of herbaceous species in grassland and to compare the frequency distribution with Raunkiaer's standard frequency diagram.
8	To estimate Importance Value Index for grassland species on the basis of relative frequency, relative density and relative dominance in protected and grazed grassland.
9	To determine the basal cover, or vegetational cover of one herbaceous community by quadrat method.
11	To study the ecological adaptation in plants to aquatic habitat (Hydrophytes)
12	To study the ecological adaptation in plants to mesophytes.
13	To study the ecological adaptation in plants to desert conditions (Xerophytes)
14	Determination of rate of transpiration in mesophytic plants.
15	To study the ecological adaptation in animals to aquatic habitat
16	To study the impact of flood on river side ecology.
17	Study of protected forest or sanctuary with respect to its conservational status.
18	Study of Ecological Modelling.

19	Determination of Shannon-Weiner Species Diversity Index
20	Determination of Kothe's Species Deficit Index of aquatic organisms.
Activity	Visit to Terrestrial/Aquatic Ecosystem

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Determine species diversity Index.
2. Determine productivity of ecosystem.
3. Calculate frequency of herbaceous species
4. Demonstrate components of ecosystem.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION

M.Sc. I (Environmental Science)

SEMESTER – I (NEP-20)

PRACTICAL II: Concepts of Ecology and Biodiversity

Time: 3 Hours **Marks: 50**

External Practical Distribution of Marks (Three hours)

Q.1 Experiments based on field ecology 10 Marks

Q.2. Experiments based on ecological adaptations 10 Marks

Total: 25 Marks

Practical Internal:

1. Record/Assignments 10 Marks

2. Attendance 05 Marks

3. Viva-voce 10 Marks

Total: 25 Marks

Syllabus prescribed for - **PG. Programme**

Programme: **M.Sc. Environmental Science**

SEMESTER-I

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods / weeks
EVS-104.1	**Land And Soil Conservation and Management**	**03**

Introduction: This paper introduces students to the fundamentals of land and soil degradation. Each unit covers a range of topics, which will help students develop basic understanding of properties of soil and how the quality of land and soil degrades due to anthropogenic activities.

COs:

After completion of this Course successfully, students would be able to:

1. Understand principles of water and land management
2. Describe the basics of hydrology, soil conservation, groundwater, irrigation and drainage, and watershed
3. Understand impact of human action on soil and land
4. Critically examine the issues of Soil and Land in the environmental perspectives
5. Apply knowledge in water and land conservation projects
6. Natural Forest, grassland, wetland etc. Eco restoration techniques and case
7. Appreciate the application of RS-GIS techniques to the matrices of environment and Resource.

Unit	Theory	Periods
Unit-I	**Fundamentals of soil science:** Land as a resource, ecological and economic importance of soil; Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps.	
Unit-II	**Soil degradation – causes:** Types and causes of soil degradation; Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its	

	regulation; nutrient depletion; soil pollution due to mining and mineral extraction, impact soil degradationon agriculture and food security; industrial and urban development, toxic organic chemicals, and organic contaminants in soils; fertilizers and fertilizer management; recycling of soil nutrients.	
Unit-III	**Land use changes and land degradation:** Land resources: types and evaluation; biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation deforestation, desertification; habitat loss, loss of biodiversity; range land degradation; land salinization; human population pressure, poverty, socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.	
Unit-IV	**Land degradation and its control:** Economic valuation of land degradation; onsite and offsite costs of land degradation; loss of ecosystem services; effects on nutrient cycles; future effects of soil degradation; emerging threats of land degradation to developing countries	
Unit-V	**Land degradation and its control:** Sustainable land use planning; role of databases and data analysis in land use planning control and management; land tenure and land policy; legal, institutional and sociological factors; integrating land degradation assessment into conservation.	
Unit-VI	**Remote Sensing and Application:** Remote Sensing: definitions and principles; electromagnetic (EME) spectrum; interaction of EMR with Earth's surface; spectral signature; satellites and sensors; aerial photography and image interpretation. Applications and case studies of remote sensing and GIS in geosciences, land use planning, forest resources, agriculture, marine and atmospheric studies.	
Learning outcome: Upon completion of this Course successfully, students would be able to: 1. Demonstrate basic knowledge of soil, its formation, physico chemical properties. 2. Apply knowledge, understanding and problem-solving abilities to stop land degradation. 3. Apply modern technology to identify land use pattern. 4. Learn legal aspects to conserve land/soil.		

Reference books

1. Environmental Science – by S.C. Santra.
2. Environmental Chemistry by B.K. Sharma.

3. Environmental Chemistry by – A. K. Dey.
4. Concept of Environmental Chemistry – G. S. Soudhi; Narosa publishing , New Delhi.
5. Environmental Chemistry by – R. C. Rsswell; Edward Armolic Press.
6. Environment, Development and sustainability – Bhaskar nath
7. Moorthy V. V. N., Land and water management, Kalyani, 2006

Syllabus Prescribed for - **PG Programme**

Programme: **M. Sc. Environmental Science**

Semester I

Code of the Course/Subject	**(Laboratory/Practical/hands-on/Activity)**	**No. of Periods/Week**
EVS/ PR/DSE II Practical	**Practical based on DSE II, Land and Soil conservation And Management**	**02**

Experiment No.	**Experiment**
1	Determination of soil temperature.
2	Determination of soil moisture by tensiometer.
3	Determination of soil bulk density.
4	Determination of soil texture by sieve method.
5	Determination of soil electrical conductivity.
5	Determination of soil pH.
6	Determination of soil acidity.
7	Determination of soil NPK.
8	Characterization of wasteland soil.
9	Evaluation of impact of refuses on soil quality.
10	Impact of air pollutants on plants leaves.
11	To examine the effects biofertilizers versus chemical fertilizers on root ramification and plant growth.
12	Mapping of the land use patterns with the help of aerial photo- graphs.
13	To study the change in land use pattern of an area with help of aerial photographs and survey if India Topo sheet.
14	Conventions with Local Farmers for Awareness about Use of Chemical Fertilizer.
15	To examine the effects biofertilizers versus chemical fertilizers on root ramification and plant growth.

Course Outcomes:

Upon completion of this Course successfully, students would be able to:

1. Understand principles of water and land management.
2. Describe the basics of hydrology, soil conservation, groundwater, irrigation and drainage, and watershed.
3. Understand impact of human action on soil and land.
4. Critically examine the issues of Soil and Land in the environmental perspectives.
5. Apply knowledge in water and land conservation projects.
6. Explain Natural Forest, grassland, wetland etc. Eco restoration techniques and case.
7. Appreciate the application of RS-GIS techniques to the matrices of environment and Resource management.

Syllabus Prescribed for - **PG Programme**

Programme: **M. Sc. Environmental Science**

Semester I

Code of the Course/Subject	**Title of the Course/Subject**	**No. of Periods/Week**
EVS-104.2	**DSE II, Environmental Pollution & Health**	**02**

Course outcomes:

After completion of this Course successfully, students would be able to:

1. Knowledge on the types and the science of environmental pollution
2. Appreciation of the effect of polluting on human health
3. Analytical ability to link cause and effect of pollution
4. Critical issues of handling pollution vis a vis human being
5. Ability to develop pollution mitigation/abetment strategies

Unit	**Content**
Unit-I	**Chemistry of environmental pollutants:** Definition of pollution; pollutants; classification of pollutants; solubility of pollutants (hydrophilic and lipophilic pollutants), transfer of pollutants within different mediums, role of chelating agents in transferring pollutants.
Unit-II	**Chemistry of environmental pollutants:** Concept of biotransformation and bioaccumulation, concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage, causes of soil pollution and degradation; effect of soil pollution on environment, control strategies.
Unit-III	**Air pollution:** Ambient air quality: monitoring and standards (National Ambient Air Quality Standards of India); air quality index; sources and types of pollutants (primary and secondary); smog (case study).
Unit-IV	**Air pollution:** Effects of different pollutants on human health (NOx, SOx, PM, CO, CO_2, hydrocarbons and VOCs) and control measures; indoor air

	pollution: sources and effects on human health. Noise pollution: sources and permissible ambient noise levels; effect on communication, impacts on life forms and humans, control measures, Radioactive material and sources of radioactive pollution.
Unit-V	**Freshwater pollution:** Sources of surface and ground water pollution; water quality parameters and standards; organic waste and water pollution; eutrophication; COD, BOD, DO; effect of water contaminants on human health (nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs).
Unit-VI	**Pollution control:** Oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management; Regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG in NCT of Delhi.

Text Books:

1. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
2. Purohit, S.S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.

Reference Books:

1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. *Air Pollution: Health and Environmental Impacts*. CRC Press, Taylor & Francis.
2. Hester, R.E. & Harrison, R.M. 1998. *Air Pollution and Health*. The Royal Society of Chemistry, UK.
3. Park, K. 2015. *Park's Textbook of Preventive and Social Medicine* (23rd edition). Banarsidas Bhanot Publishers.
4. Vesilind, P.J., Peirce, J.J., & Weiner R.F. 1990. *Environmental Pollution and Control*.Butterworth-Heinemann, USA.

Syllabus Prescribed for - **PG Programme**

Programme: **M. Sc. Environmental Science**

Semester I

Code of the Course/Subject	**(Laboratory/Practical/hands-on/Activity)**	**No. of Periods/Week**
EVS-107.1	**Practical based on DSE II, Environmental Pollution & Health**	**02**

Experiment No.	**Experiment**
1	Measurement of particulate matter in air by grab sampling and gravimetric method.
2	Understanding levels of SO_X and NO_X in ambient air.
3	Sampling methods of water.
4	Understanding and comparing noise levels of localities
5	Determination of TS, TDS and TSS of water sample.
6	Determination of nitrate, sulphate content from waste water.
7	Determination of BOD and COD of waste water
8	Determination of MPN of water sample.
9	Study of competitive efficiency of ETP/ WTP.
10	Estimation of soil organic matter.
	Field visit: Visit to a local polluted site- Urban/Rural/Industrial/Agricultural, sampling, analysis and reporting

Learning Outcomes:

Upon completion of this Course successfully, students would be able to:

1. Assess degree of pollution in drinking and waste water.
2. Identify types of water and air pollutants.
3. Determine efficiency in water Treatment.

SANT GADGE BABA AMRAVATI UNIVERSITY, AMRAVATI PRACTICAL EXAMINATION
M.Sc. I (Environmental Science)
SEMESTER – I (NEP-20)
PRACTICAL III: DSE I and DSE II

Time: 3 Hours **Marks: 50**

External Practical Distribution of Marks (Three hours):

Experiments based DSE-I

Q. 1. Experiment on Physical Properties of soil (any two)	10 Marks
Q. 2. Experiments based chemical properties of soil (any two)	10 Marks
Q. 3. Experiment on Interpretation of land aerial photos.	05 Marks

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Total: 25 Marks

OR

Experiments based DSE-II

Q. 1. Major Experiment on Water analysis	15 Marks
Q. 2. Minor experiments on water analysis (any two)	10 Marks

Total: 25 Marks

Practical Internal:

1. Record/ Assignments / Reports-	10 Marks
2. Attendance	05 Marks
3. Viva-voce	10 Marks

Total: 25 Marks

Syllabus prescribed for- **PG. Programme**

Programme: **M.Sc. Environmental Science**

Semester II

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods / weeks
EVS-201	**Environmental Microbiology**	**04**

COs:

After completion of this Course successfully, students would be able to:
1. Understand the fundamental concepts of microorganism and the environment.

2. Use the basic concepts in microbiology of air and soil.

3. Use the basic concepts in microbiology of water.

4. Apply the fundamental concepts in food microbiology.

5. Gain the basic concepts in industrial application of microorganism.

6. Understand the basic concepts about infection and diseases.

Unit	Theory
Unit-I	**Microorganisms and the Environment:** Microorganisms and the structure of ecosystems. The physiological state of microorganisms in Ecosystems. Role of Surfaces & Biofilms, Microbial mats in ecology. Techniques used for environment of microbiological culture concept. Concept and Method of pure culture, preparation, maintenance and preservation of microbial culture, types of culture, sterilization and disinfections. The influence of environmental factors on growth.
Unit -II	**Microbiology of Air & Soil:** Distribution of microbes in air, Allergic disorders by air microflora, fungal and pollen allergens. Collection and enumeration of aeroallergens. Microbiology of soil – soil, habitats, microbial biogeochemical cycling. Nutritional types of organisms. Nitrogen fixation.
Unit-III	**Microbiology of Water:** The microbial community in Marine and Fresh water environments. Aquatic nutrient cycles - Carbon, Nitrogen, Phosphorus & Sulphur. Bacteriological analysis of water. Sewage and waste water microbiology, Biodegradation of Industrial wastes.
Unit-IV	**Microbiology of food:** Microorganisms and food spoilage. Microbial examinations of food. Food processing and methods of preservation. Preservation alternatives. Microbial examination of milk & dairy products. Important fermented food. Disease and foods. Microorganisms as sources of food.
Unit-V	**Industrial Applications of microorganisms:** Role of microorganisms in the production process of products medicines (Pharmaceuticals) organic acids, amino

	acids, Enzymes, fuels, Alcoholic beverages, Enhanced recovery of metals, petroleum products.
VI	**Infection and Disease:** Disease definition, types of diseases, water borne, soil borne, air borne diseases. Transmission of disease, Establishment of disease, resistance to disease. Immune disorders - bacterial and viral disease of man. Control of microorganisms by physical and chemical agents.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Acquire knowledge of microbiology environmental components.
2. Ability to integrate basic knowledge microbiology for its industrial applications.
3. Develop problem solving abilities in spreading and control of infection and diseases.
4. Acquire knowledge and skill to utilize microbes in value addition and preservation of food.

Recommended Books:

1. Microbiology by:- Pelezar.
2. Introduction Microbiology:- Stainer.
3. Introduction to Microbiology :- Modi
4. Mcirobiology of the atmosphere:- Gregary, P.H. Wiley & Company.
5. Microbiology:- LM Prescott John P. Harley, Bonald. A.Klein 4th Ed. WCB/McGraw – Hill.
6. Microbiology Fundamental and Application :- Ronald M. Atlas and Richard Bartha 4th Ed. Aim Print of Addison Wesley Long Man Ine.
7. The Microbil World :- Stainer et.al, P.H. I, 1990.
8. Medial Microbiology :- Anant Narayan.
9. General Microbiology :- Robert F. Boyd. /Times, Mirror/Mosby College publishing st. lawisis, Toronto/ Santa Clara. 1984.
10. Microbiology :- P.D. Sharma (1993). Rastogi and Company, Meerut, India.
11. Fundamental Principals of Bacteriology:- Salle, A.J. (1986).
12. Microbiology of Extreme Environment:- Clave Edwards.
13. Microbiology for Environmental Scientists & Engineers:- Gindyh, A.F. and Gandy. E. (1982) McGraw Hill, N.Y.
14. Microbiology An Environmental Perspective:- Paul Edmonds(1978) Max Milan Publishing.
15. Basic Microbiology:- Brock, T.D., K.M. Book and D.M. Ward (1996) (III edition).
16. General microbiology – Power and Dagniwala
17. Microbiology – P.D. Sharma
18. Fundamental principle of bacteriology – P.C. Salle
19. Microbiology – Pelczar, M.S. Chand.
20. Introduction to Microbiology – Kappor and Touro
21. Microbiology – Maheswari and Dubey
22. Encyclopedia of environmental microbiology – P. Hotter
23. Industrial microbiology – K.C. Daa

24. Medical microbiology – Anant Narayana

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Programme: **M. Sc. Environmental Science**

Semester II

Code of the Course/Subject	**(Laboratory/Practical/Practicum/hands-on/Activity)**	**No. of Periods/Week**
EVS-205	**Practical based on DSC IV.2 Environmental Microbiology**	**02**

COs:

After completing this course successfully, students would be able to:

1. Perform experiments on environmental microbiology.
2. Perform qualitative and quantitative microbial analysis of water sample.
3. Identify microbial contaminants.
4. Provide consultancy services work in the field of environmental microbiology.

Experiment No.	**Experiment**
1	Microscopy - a) Use of compound microscope b) Calibration of microscope
2	Staining Techniques - a) Monochrome staining b) Negative Staining c) Gram Staining d) Special Staining Methods
3	Slide culture techniques for examination of fungi /actinomycetes.
4	Estimation of total viable counts in water and soil samples.
5	Preparation and sterilization of microbial media.
6	Determination of total bacterial and fungal count from garbage piles in housing colonies.
7	Determination of most probable number (MPN) in water samples.
8	Staining of bacterial suspension by simple staining method(monochrome)
9	Staining of bacterial suspension by Hooker's modification orby Gram's staining.
10	Study of microorganisms by Standard Plate Count (SPC) method
11	Isolation of bacteria from water, soil, decaying matter.
12	Isolation of fungi from soil/ water/ decaying matter.
13	Identification and classification of bacteria.
14	Study of allergenic and non-allergenic pollen grains.

15	Study of laboratory instruments used for microbiological study.
16	Study of preparation of sterilization of culture media.
17	Determination of MPN from drinking water resource for potability.
18	Determination of hydrogen sulfide (H_2S) from sewage sample.

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SEMESTER – II (NEP-20)

PRACTICAL IV: Environmental Microbiology

Time: 03 Hours **Marks: 50**

Practical- (Internal)- Distribution of Practical Marks.

Q.1. Practical Record & assignments (if any) 15 Marks

Q.2. Viva-voce 10 Marks

Total Marks: 25

Practical External -Distribution of Practical Marks (3 Hrs.)

Q.1. Major Experiment on Environmental Microbiology 15 Marks

Q.2. Minor Experiment on Environmental Microbiology 10 Marks

Total Marks: 25

Syllabus prescribed for- **PG Programme**

Programme: **M.Sc. Environmental Science**

Semester-II

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods / weeks
EVS-202	**Air and Noise Pollution**	**04**

COs:

After completing this course successfully, students would be able to:

1. Apply the concepts related with air pollution.
2. Appreciate the concepts related with global air pollution problems.
3. Use air monitoring instruments
4. Understand the concepts of air pollution meteorology.
5. Analyse noise pollution

Unit	Theory
Unit-I	**Air pollution:** Definition, natural and manmade sources of air pollution, stationary and mobile sources, primary and secondary pollutants, transport and diffusion of pollutants, emission and ambient standards, vehicular pollution and urban air quality.
Unit -II	**Air pollutants:** Sulfur oxides (SO_x); nitrogen oxides (NO_x), carbon monoxide, total suspended particulate matter, respirable particulates, photochemical oxidants, specific pollutants (Hydrogen sulphide, particulate fluoride, formaldehyde and volatile organic compounds), chemical composition of SPM photochemical smog, peroxy acyl nitrates (PAN), benzo-a-pyrene (BAP)formations, Dioxin, atmospheric sinks.
Unit-III	**Global air pollution problems:** Green-house effect (green-house gases: CO_2, CH_4, N_2O, CFC's, water vapor concentration, alternatives for CFC's, fire extinguishers, global warming and climate change, ozone layer depletion (ozone depleting processes, ozone hole, environmental effects and strategies for ozone layer protection), acid rain.
Unit-IV	**Effects of air pollution and air monitoring instruments:** Human health, plants, animals and microbes, archaeological monuments and aesthetics, Orsat apparatus, high volume air sampler and source monitors, Status of Air pollution in India.
Unit-V	**Air pollution meteorology:** Wind speed, direction and their vertical profiles, turbulence (mechanical and thermal), atmospheric stability characteristics and classes, Plume behaviour, wind-valley effects, land/sea breeze-effects, heat

	island effect, mixing height-boundary layer definition, temperature inversions, factors affecting on dispersion of air pollutants
Unit-VI	**Noise pollution:** Properties of sound waves, sound level meters, definition of noise, industrial community noise factors, effects of noise on human beings, hearing mechanism, audiometric tests, effects on human performance, noise standards and guidelines, permissible noise levels for occupational exposures, noise pollution control and abatement measures.

Learning outcomes:
Upon completion of this Course successfully, students would be able to:

1. Acquire knowledge of types, its sources and dynamics of air pollutants.
2. Understand standard limits of air pollutants in environment.
3. Understand global environmental issues related to air pollution.
4. Identify specific effects of air pollutants on environment.

Recommended Books:

1. Magill, Holden and Ackdey, Air Pollution Hand Book, Mc-GrawHill, New Delhi (1998)
2. R. K. Trivedi & P. K. Goel, An Introduction to Air Pollution,TechnoScience Publications, Jaipur (1995)
3. C.S.Rao, Environmental Pollution Control Engineering, New AgeInternational Publication New Delhi (2001)
4. Sharma & A. Roychaudhari, The Deadly Story of Vehicular Pollution in India, CSE New Delhi (1996)
5. Wahi S.K., Agnihotri A. K., and Sharma J.S.,Environmental Management, Willey Eastern Ltd., New Delhi. (1992)
6. G. N. Pandey, and G.C. Carney, Master Gillbert M., Introduction to Environmental Engineering and Science, Prentice Hall, New Delhi(2000).
7. E. Robart Alley and Associates, Air Pollution Control Hand- book,Mc-Graw Hill, New Delhi (1998)

Syllabus prescribed for- **PG. Programme**

Programme: **M.Sc. Environmental Science**

Semester II

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods/weeks
EVS-203	**Water Pollution**	**03**

COs:

After completing this course successfully, students would be able to:

1. Understand the concepts related with characteristics of water, waste water and sources of water pollution.
2. Analyse pollution potential of industrial effluents.
3. Protect water resources and environment.
4. Get acquainted with consequences of water pollution.
5. Understand the concepts sustainable water management.

Unit	Theory
Unit-I	**Characteristics of water and waste water:** Physical, chemical, and biological characteristics of water and wastewater, physiochemical and bacteriological sampling and analysis of water quality. Phytoplankton, zooplankton and macrophytes in aquatic ecosystem.
Unit-II	**Water quality standards:** Water and waste water quality standards (BIS, WHO, CPCB and US Environmental Protection Agency), Water quality indices: definition, types, applications and significance, water quality for industrial and bathing purpose, prevention and control of water pollution, Quality standards of sewage treatment plant effluent.
Unit-III	**Sources of Water pollution:** Sources of water pollution from urban, industrial, agricultural and natural waters, interaction in aquatic system, sources of marine pollution, criteria for disposal of pollutants in marine ecosystem, coastal management.
Unit-IV	**Pollution potential of industrial effluents:** (Process, sources and qualitative and quantitative characteristics effluent) Nuclear/thermal power stations, agriculture, sugar, food processing, chemical, tanneries, pulp and paper, oil and petroleum, textile and electroplating industries.
Unit-V	**Water resources and environment:** Global water balance. Origin and composition of sea water, types of water: surface, ground water, brackish and marine water, human use of surface and ground water, exploration of ground water, ground water table, aquifers. Design, construction and maintenance of wells and infiltration galleries. Concept of sustainable water management.
Unit-VI	**Consequences of water pollution:** Biological uptake of pollutants and their effects on land, vegetation, animals and human health, bio-deterioration,

	bioaccumulation, biomagnifications and eutrophication. Bio-indicators: specific pollutants in aquatic system and their speciation, behaviour, toxicity.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Learn physico-chemical and microbial characteristics of polluted water.
2. Understand water quality parameters and their standard limits prescribed by standard institution.
3. Integrate knowledge and handle water resources for prevention and control of water pollution.
4. Identify possible consequences of water pollution.

Text Book:

1. Water pollution: Causes treatment and effects. By- Laxmi Begum
2. Water pollution: Causes control and treatment. By Sherry McMillan
3. Water pollution: Causes effects and control. By P. K. Goel
4. Ecology Environment and pollution By- Ranjan and Purohit

Reference Books:

1. Gerard Kiely, Environmental Engineering Vol. I, II, & III Liptak, Tata McGraw Hill, New Delhi. (1998)
2. A.K. De, Environmental Chemistry. 2nd edn., 1990, Wiley Eastern Ltd., New Delhi.
3. Nancy J. Sell, Industrial Pollution Control, John Willey and Sons, Inc., New York (1992)
4. S.S. Dara A Text Book of Environmental Chemistry and Pollution Control, S. Chand, and Co. Ltd., New Delhi. (1995)
5. P. K. Goal and K. P. Sharma, Environmental Guidelines and Standards in India, Techno science Pub. Jaipur, India (1996)
6. G. R. Pathade, and G. K. Goal, Environmental Pollution and Management of Waste Water by Microbial Techniques, A. B.D. Pub. Jaipur India (2001)
7. S. N. Jogdand, Environmental Biotechnology (Industrial Pollution Management) Himalaya Pub. House Delhi. (1995)
8. Water quality, pollution and management. By- Raven Spoon

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Programme: **M. Sc. Environmental Science**

Semester II

Code of the Course/Subject	**(Laboratory/Practical/practicum m/hands-on/Activity)**	**No. of Periods/Week**
EVS-206	**Practical based on DSC V& VI .2 Air and Noise Pollution & Water Pollution**	**04**

A. Experiments based on Air and Noise Pollution:	
1	Determination of local weather parameters by using micro-meteorological equipment.
2	To study principle, components and working operation of Respirable d dust sampler/ High volume sampler.
3	Determination of NOx from ambient air sampler.
4	Determination of SOx from ambient air sampler.
5	Determination of RSPM, TSPM and Settleable Particulate matter from ambient air by high Volume Sampler.
6	Determine settleable Particulate Matter from ambient air by paper method
7	Measurement of Noise levels.
8	Principal and working of noise level meter.
9	Qualitative demonstration of burning of coal releases soot particles, sulfur dioxide and Carbon dioxide.
B. Experiments based on Water Pollution:	
1	Determination of oil / grease in water.
2	Determination of Inorganic Phosphorus in water.
3	Estimation of chlorides in water sample by Mohr's method.
4	Estimation of Residual chlorine in water sample by iodometric method.
5	Estimation of sulphate in water sample by turbidimetric method.
6	Estimation of ferric and ferrous ions present in water.
7	Estimation of Nitrate in water.
8	Determination of chemical oxygen demand (COD) in wastewater.
9	Determination of Biological Oxygen demand (BOD) of wastewater.
10	Determination of total acidity CO2 in Water.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Determine the weather conditions.
2. Determine degree of air pollutants in ambient air.
3. Acquire skill to operate air sampler and analysis.
4. Measure the degree of water contaminant in water.

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M.Sc. I (Environmental Science)

SEMESTER – II (NEP-20)

PRACTICAL V: DSC V & VI Air and Noise Pollution & Water Pollution

Practical Marks distribution:

1. Practical Record- 20 Marks
2. Practical assignment /survey- 10 Marks
3. Attendance/Sincerity – 10 Marks

Total: 50 Marks

External Practical - Distribution of Practical Marks (6 Hrs.)

Q.1. Major Experiment on Water Pollution 10 Marks

Q.2. Minor Experiment on Water Pollution 05 Marks

Q.3. Major Experiment on Air Pollution 10 Marks

Q.4. Minor Experiments on Water pollution 05 Marks

Q.5. Experiments on noise pollution 10 Marks

Q.6. Viva-voce 10 Marks

Total: 50 Marks

Syllabus prescribed for- **PG. Programme**

Programme: **M.Sc. Environmental Science**

SEMESTER-II

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods / weeks
EVS-204.1	**Natural Hazards and Disaster Management**	**03**

Introduction: This paper introduces the students to various aspects of environmental hazards, their causes, classifications, and impacts. It also focuses on the management strategies and governmental action plan to mitigate and prepare for such hazards

COs:
Upon completion of this Course successfully, students would be able to:

1. Understand the different types of natural hazard, their major driving forces/factor, and the causes.
2. Understand the relationship/interface between geophysical processes and human activities in causing natural hazard
3. Explain Hazards Scenario at the global as well as National level
4. Understand the mitigation approaches, their choices and alternatives
5. Develop foundations for hazard, risk and vulnerability assessment

Unit	Theory
Unit-I	**Natural hazards:** Define Hazard; concept of risk and vulnerability; reasons of vulnerability. Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, floods: types and nature, landslides: causes and types of landslides; drought: types of droughts - meteorological, agricultural, hydrological, and famine; tornadoes, cyclone & hurricanes; tsunamis.
Unit-II	**Anthropogenic hazards:** Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation, mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains. Deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.
Unit-III	**Risk, Vulnerability, Mitigation and preparedness:** Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses,and intangible losses); Concept of mitigation; types of mitigation: structural and non-structural.

Unit-IV	Deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones; nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.
Unit-V	**Risk, Vulnerability, Mitigation and preparedness:** Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses,and intangible losses); mitigation, concept of preparedness; importance of planning, exercise, and training inpreparedness; role of public, education and media in hazard preparedness.
Unit-VI	**Disaster management in India:** Lessons from the past: Bhuj earthquake, tsunami disaster, and Bhopal tragedy; National Disaster Management Framework, national response mechanism, role of government bodies suchas NDMC and IMD; role of armed forces and media in disaster management; role of space technology in disaster management; case study of efficient disaster management during cyclone '*Phailin*' in 2013. Concept of mitigation; types of mitigation: structural and non-structural.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Acquire types of Natural hazards.
2. Identify vulnerable areas to specific natural hazard.
3. Acquire possible man-made hazard and assess its risk.

Text Books:

1. Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis Publishers, New York, NY.
2. Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Rout ledge Press.

Reference Books:

1. Coppola D. P. 2007. *Introduction to International Disaster Management*. Butterworth Heinemann.
3. Cutter, S.L. 2012. *Hazards Vulnerability and Environmental Justice*. Earth Scan, Routledge Press.
4. Keller, E. A. 1996. *Introduction to Environmental Geology*. Prentice Hall, Upper Saddle River, New Jersey.
5. Pine, J.C. 2009. *Natural Hazards Analysis: Reducing the Impact of Disasters*. CRC Press, Taylor and Francis Group.
6. Wallace, J.M. & Hobbs, P.V. 1977. *Atmospheric Science: An Introductory Survey*. Academic Press, New York.
7. Wasson, R.J., Sundriyal, Y.P., Chaudhary, S., Jaiswal, M.K., Morthekai, P., Sati, S.P.&Juyal, N. 2013. A 1000-year history of large floods in the upper Ganga catchment, central Himalaya, India. *Quaternary Science Reviews* **77**: 156–166.

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Programme: **M. Sc. Environmental Science**

Semester II

Code of the Course/Subject	**(Laboratory/Practical/hands-on/Activity)**	**No. of Periods/Week**
EVS-207.1	**Practical based on DSE-Natural Hazards & Disaster Management**	**02**

Experiment No.	**Experiment**
1	To study the impact of flood on ecology.
2	Visit to landslide area and survey
3	To study the property of rocks and minerals.
4	To study the impact of mining on ecosystem.
5	To study hazard maps of potential hazards like earthquake/flood etc. of specific area using GIS software.
6	To study emergency response during emergencies situation such as earthquake/flood etc. (with the help of simulation.)
7	To study flood management strategies. (with the help of Model)
8	Study of any one case studies of real-life natural disaster.
9	Study of evacuation planning for a community at risk.

Learning Outcomes:

Upon completion of this Course successfully, students would be able to:

1. Acquire knowledge of flood ecology. 2. Identify flood prone area. 3. Able to decide strategies for saving life and property. 4. Interpret hazard maps.

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SEMESTER-II

Code of the Course/Subject	Title of the Course/Subject	Total number of Periods/ weeks
EVS-204.2	**Energy resources and sustainable development**	**03**

COs:

Upon completion of this Course successfully, students would be able to:

1. Classify the energy resources into conventional and non-conventional energy resources
2. Recognize the power and applications of solar energy
3. Describe the environmental aspects of non- conventional energy resources
4. Know the need of renewable energy resources, historical and lates development
5. Acquire the knowledge of biomass, hydropower generation, geothermal energy
6. Explain carrying capacity of ecosystem.
7. Apply concept of sustainable development to address sustainable challenges in a global context.

Unit	Theory
Unit I	**Energy resources:** Introduction to energy resources, sources of energy and their classification Energy use pattern in developed and developing countries, Energy use pattern in India and different parts of the world, energy crisis, role of IREDA and MEDA in energy generation.
Unit II	**Conventional energy resources:** Classification, composition, physicochemical characteristics, energy content of coal, petroleum and natural gas, formation, reserves, exploration/mining and uses of coal oil and

	natural gas, environmental problems associated with exploration/mining, processing, transportation and uses.
Unit III	**Solar energy and wind energy:** Sun as a source of energy, harnessing of solar energy, solar collector, solar electricity generation, solar heaters and cookers, Photovoltaic cell Wind power, Harnessing of wind energy through wind mill, concentrators,
Unit IV	**Biomass Energy:** Biomass composition and types, conversion processes – pyrolysis, charcoal production, compression, gasification and liquification, energy plantation. Biogas- production and usage, anaerobic digestion, types of digesters.
Unit V	**Hydropower and geothermal energy:** a. Principle and generation of hydroelectric power, energy from oceans (OTEC), tidal energy, wave energy. b. Geothermal energy-Sources, crust, high temperature aquifers, low temperature aquifers, reserves, harnessing of geothermal energy-problems and prospects.
Unit VI	**Sustainable development:** Sustainable development: Concept, definition and principles of sustainable development, barriers to sustainable development, aspects of sustainable development, practices of sustainable development in India.

Learning Outcomes:
Upon completion of this Course successfully, students would be able to:

1. Acquire knowledge of energy use pattern in India and out of India,
2. Understand status and its impact of conventional energy resources.
3. Identify types and importance of non-conventional energy resources.
4. Understand process of generation energy from biomass and geothermal sources.

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Semester II

Code of the Course/Subject	**(Laboratory/Practical/Practicum/hands-on/Activity)**	**No. of Periods/Week**
EVS-207.2	**Practical based on DSE-IV. Energy Resources & sustainable development**	**02**

Experiment. No.	**Experiments**
1	Performance testing of solar cooker.
2	Estimation of wind speed using anemometer.
3	Study on solar photovoltaic panel in series combination.
4	Study on solar photovoltaic panel in parallel combination.
5	To study Solar water heater.
6	To study biogas plants.
7	To study gasifier.
8	To study solar photovoltaic system.
9	To study solar drying system.
10	To estimate the calorific value of coal.
11	To estimate the biomass of grazed and un-grazed land.

Learning Outcomes:

Upon completion of this Course successfully, students would be able to:

1. Determine extent of biomass.
2. Understand working of biogas plant.
3. Measure wind speed and find its direction.
4. Estimate calorific value of biomass.

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IPRACTICAL: VI DSE III and DSE IV

Time: 3 Hours **Marks: 50**

External Practical Distribution of Marks (Three hours):

Experiments based DSE-III

Q. 1. Experiment on Disaster Management. 10 Marks

Q. 2. Experiments mapping /Interpretation of Hazards. 10 Marks

Q. 3. Experiment on dentification of rocks/minerals. 05 Marks

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Total Marks: 25

OR

Experiments based DSE-IV

Q. 1. Find the calorific value of given fuel. 10 Marks

Q. 2. Estimation of Biomass. 10 Marks

Q. 3. Demonstration of Non-conventional sources. 05 Marks

Total Marks: 25

Practical Internal:

1. Record/Assignments/Reports	10 Marks
2. Attendance	05 Marks
3. Viva-voce	10 Marks

Total Marks: 25