SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2T01NCENS01**	Environmental Microbiology and Ecology	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Explain fundamental concepts of ecology, ecosystem structure, environmental components, and energy flow including food chains, food webs, and ecological pyramids.

CLO2: Analyze the effects of abiotic (light, temperature) and biotic factors (mutualism, parasitism, competition, etc.) on organism interactions and ecosystem functioning.

CLO3: Interpret ecological principles such as Liebig's law of minimum, Shelford's law of tolerance, biological clocks, and their role in autecology and population regulation.

CLO4: Evaluate population and community ecology, including population dynamics, community structure, ecological succession, and methods of ecological study.

CLO5: Assess the structure, function, and environmental issues of aquatic ecosystems (lentic, lotic, wetlands) including eutrophication and biodiversity restoration strategies.

CLO6: Analyze marine ecosystems, biogeochemical cycles, and environmental pollution (oil spills, hydrocarbons, coastal pollution) and their ecological impacts.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Environmental complexes- Ecology, Ecosystem, Environment and their concepts. Limiting and inhibiting effects of light and temperature. Biotic factors- Relationship between organisms- Mutualism, commensalisms, parasitism, competition, antibiosis, predation. Concept of ecology- Food chain - grazing food chain and detritus food chain, food web. Ecological pyramids - Number, biomass and energy, energy flow models and budget. Concepts of productivity and determination of productivity in different ecosystems. **Sacred rivers, groves, animals in ecology.**	Lecture-based teaching, ICT enabled learning, Concept mapping, Inquiry-based learning, Self-directed learning	CLO1, CLO2
II	Autecology- biological clocks along with influence factors, Liebig's law of minimum and Shelford's law of Tolerance. **Seasonal cycles and agricultural calendars.** Population ecology - Describing population characters, Dynamics and regulation. Community Ecology- Composition, structure, origin and characters used in community structure. Analytical and synthetic characters. Methods of studyof community. Ecological succession: primary and secondary processes of successions, climax community.	Problem based learning (PBL), Collaborative learning, Research oriented learning, Flipped classroom approach	CLO3, CLO4

III	Aquatic ecosystems- Wetlands, Ramsar sites and conservation of wetland. Physical, chemical and biological characters of lentic, lotic ecosystems. Eutrophication: Sources and consequences. Restoration of biological diversity: reintroduction of biota, **Degradation and restoration of Forests ecosystems, grassland ecosystems, aquatic ecosystems (wetlands)**, Restoration of wastelands and degraded soils: Bio-geo-chemical cycles- Car on, nitrogen, phosphorous, sulfur-involvement of organisms	Field visit/experiential learning, Case based learning, Micro- projects, Data analysis exercises, Simulation and role- play	CLO5
IV	Marine Environment: Zonation pattern, physical – tides, light, temperature, density, salinity, chemical – Phosphate, sulphate, nitrate, D.O, and biological characters-plankton, nektons and benthos, types of biomes. Sources of pollution, oil-pollution, Hydrocarbons- polycyclic and petroleum hydrocarbons, Coastal pollution: Coral reefs, Estuaries and Mangroves.	Seminar/ presentation, Research oriented learning, ICT-enabled learning, Collaborative learning, Reflective practices	CLO6

(*) Learning Pedagogies/Methods

Notes:
(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.
(2) Acronyms/abbreviations of the terms can be placed in the above table.

(a) Interactive Classroom Lecture
(b) Classroom Lecture (CL)
(c) Seminars (Student-led and Faculty-moderated)
(d) Micro-Projects/Mini Research Tasks
(e) Industrial Visit/Field Visit/Institutional Visit
(f) Problem-Based Learning (PBL)
(g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
(k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30)

(a) Quiz
(b) Assignment
(c) Seminar/Presentation
(d) Group Task
(e) Attendance

b. Internal Summative Assessment (20)

(a) Mid-Term
(b) External Assessment (50)
(c) End-Term

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CLO1, CLO2	30	1	1	12	14
II	CLO3, CLO4	32	1	1	10	12
III	CLO5	28	1	1	10	12
IV	CLO6	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	–	–	2	–	–	2	3	2
CLO2	3	3	–	2	–	–	–	2	3	2
CLO3	2	3	–	2	–	–	–	2	2	2
CLO4	2	3	–	2	–	–	–	2	2	2
CLO5	2	3	2	3	2	–	–	3	3	3
CLO6	2	2	2	3	2	–	–	3	2	3

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

- **Suggested Learning Materials Books:**

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Fundamentals of Ecology	Dash, M.C.	2011 (reprint requested; earlier verified editions available)	McGraw-Hill Education
2	Stream Ecology	David, A.	1995	Kluwer Academic Publishers
3	Marine Chemistry	Horney, A.R.	1978	Wiley
4	Estuarine Nutrient Cycling: Influence of Primary Producers	Nelson, S.L.; Gerry, T.B.; Morten, F.P.	2004	Kluwer Academic Publishers
5	Fundamentals of Ecology	Odum, E.P.	-	Nataraj Publishers
6	International Encyclopedia of Ecology and Environment (Vol. I–XVI)	Priya Rajan Trivedy et al.	1994	Indian Institute of Ecology and Environment
7	Eutrophication Process in Coastal Ecosystems	Robert, J.L.	2001	CRC Press
8	Environmental Science	Santra, S.C.	2001	New Central Book Agency
9	Ecology and Environmental Biology	Sharma, P.D.	2012	Rastogi Publications
10	Environmental Biology	Verma, P.S. & Agarwal, V.K.	2010 (2nd)	S. Chand Publishing

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL Courses on Ecology, Ecosystems and Environmental Science	https://nptel.ac.in
2	UNEP Ecosystem and Biodiversity Resources	https://www.unep.org
3	Ramsar Convention on Wetlands (Wetland Conservation Resources)	https://www.ramsar.org
4	US EPA Ecological and Environmental Information	https://www.epa.gov
5	National Geographic Ecology and Ecosystem Learning Resources	https://www.nationalgeographic.org

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

Course Type	Course Code	Course Title	Teaching- Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2T01NCENS02**	Air Pollution and Climate Change	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Explain the definition, history, sources, types, and effects of air pollution, including major atmospheric pollutants and their impact on living organisms and materials.

CLO2: Analyze air pollution phenomena such as photochemical smog, automobile emissions, and major pollution episodes, along with emission standards and control strategies.

CLO3: Evaluate air quality monitoring techniques, meteorological influences, and methods for prevention and control of particulate and gaseous pollutants.

CLO4: Interpret atmospheric structure, chemical processes, and mechanisms involved in climate change, ozone depletion, and global warming.

CLO5: Assess global environmental issues, including climate change impacts, pollutant dispersion, international protocols, and sustainability mechanisms (CDM, carbon trading).

CLO6: Apply concepts of disaster management to analyze causes, impacts, and mitigation strategies for natural and environmental hazards.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Definition, history, sources of air pollution - natural and anthropogenic, primary and secondary, Aeroallergens - sources, biology and health effects, general effects of atmospheric pollutants (PM, HC, CH4, CO2, H2S, CO, NOx, SOx) on humans, animals, plants and materials; Ambient air quality emission standards, automobile pollution (photochemical oxidants, photochemical smog), characteristics - auto exhaust, and its control (catalytic converters), air pollution episodes (Bhopal, Chernobyl, Los Angeles, London smog, Indonesian forest fire), recent case studies on air pollution	Lecture-based teaching, ICT-enabled learning, Inquiry-based learning, Self-directed learning	CO1, CO2
II	Environmental factors and air pollution - heat, insulation, wind, precipitation, plume behavior, sampling and measurement of air pollution - ambient air and stack monitoring, indoor air pollution, indoor air quality, prevention and control of air pollutants - particulate matter & gaseous pollutants – absorption, adsorption, settling chambers, fabric filters, scrubbers, cyclone & electrostatic precipitators, Clean Development Mechanisms (CDM): carbon sequestration, carbon footprint, carbon trading, carbon market.	Problem-based learning (PBL), Laboratory/field-based learning, Research-oriented learning, Data analysis exercises, Collaborative learning	CO2, CO4

III	Climate Change: Definition of Climate and weather, Chemical reactions of different chemical species in the atmosphere, Oxygen and ozone chemistry and ozone-hole formation. greenhouse gases- global warming, temperature inversion, global effects of GHGs, Classification of Climates, causes and consequences of Climate changes, Impacts of climate change on ecosystems, Global dispersion of toxic substance: Dispersion and circulating mechanisms of pollutants, ozone depletion, dust dome effect, acid rain, photochemical smog, heat island, Kyoto Protocol, Role of IPCC, Climate change methodologies. **Harmful effects of Modern Agricultural Practices: Soil erosion, Loss of Biodiversity, Climate Change, Chemical contamination, Pollution, Human health issues, etc.**	Lecture-based teaching, ICT-enabled learning, Seminar/presentation, Research-oriented learning, Flipped classroom approach	CO3, CO4
IV	Disaster management- Concept of disasters, causes, prevention and correction hazards related to Earthquakes, Tsunami, Volcanic eruption, Cyclones, Floods, Drought, Landslides, Forest fires, Avalanches and Pest infestation, El Nino and La Nina	Simulation and role-play, Experiential learning, Collaborative learning, Reflective practices	CO4, CO5

- **(*) Learning Pedagogies/Methods**

  Notes:
  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.
  (2) Acronyms/abbreviations of the terms can be placed in the above table.

  (a) Classroom Lecture (CL)
  (b) Seminars (Student-led and Faculty-moderated)
  (c) Micro-Projects/Mini Research Tasks
  (d) Industrial Visit/Field Visit/Institutional Visit
  (e) Problem-Based Learning (PBL)
  (f) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (g) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (h) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (i) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (j) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (k) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

  (A) Internal Assessment

  a. Internal Formative assessment (30)

  (a) Quiz
  (b) Assignment

(c) Seminar/Presentation
(d) Group Task
(e) Attendance

b. Internal Summative Assessment (20)

(a) Mid-Term
(b) External Assessment (50)
(c) End-Term

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CO1, CO2	30	1	1	12	14
II	CO2, CO4	32	1	1	10	12
III	CO3, CO4	28	1	1	10	12
IV	CO4, CO5, CO6	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

CLOs – PLOs Matrix

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	–	–	2	–	–	2	2	2
CLO2	2	3	2	3	–	–	–	2	3	3
CLO3	2	3	3	3	–	–	–	2	3	3
CLO4	3	3	2	3	–	–	–	3	3	3
CLO5	2	3	2	3	2	–	–	3	2	3
CLO6	2	2	–	3	3	–	–	3	2	3

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	*Environmental Chemistry*	A.K. De	1987	Wiley Eastern Limited
2	*At Risk: Natural Hazards, People's Vulnerability, and Disasters*	P. Blaikie, T. Cannon, I. Davis, B. Wisner	1994	Routledge
3	*Climate Change*	W.J. Burroughs	2001	Cambridge University Press
4	*Atmospheric Chemistry*	P.V. Hobbs	2002	Cambridge University Press
5	*Global Warming*	J. Houghton	2001	Cambridge University Press
6	*Global Warming: A Very Short Introduction*	M. Maslin	2008	Oxford University Press
7	*Air Pollution*	M. Rao	2002	Prentice Hall
8	*Air Pollution: Physical and Chemical Fundamentals*	J.H. Seinfeld	1975	McGraw-Hill
9	*Air Pollution*	B.K. Sharma	2002	Academic Press
10	Chemistry of Atmosphere	R.P. Wayne	2003	Oxford University Press

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	IPCC Reports on Climate Change and Global Warming	https://www.ipcc.ch
2	Central Pollution Control Board (CPCB) Air Quality Monitoring Data	https://cpcb.nic.in
3	WHO Air Quality Guidelines and Health Impacts	https://www.who.int
4	NASA Climate Change and Atmospheric Science Resources	https://climate.nasa.gov
5	UNEP Air Pollution and Climate Action Resources	https://www.unep.org

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M.Sc. Environmental Science SEMESTER I

Course Type	Course Code	Course Title	Teaching- Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2T01NCENS03**	Environmental Chemistry and Geology	4-0-1	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Explain fundamental chemical principles including bonding, reactions, and properties relevant to environmental systems.

CLO2: Describe concepts and applications of green chemistry for sustainable environmental management.

CLO3: Analyze Earth systems including lithosphere, atmosphere, hydrosphere, and related geological processes.

CLO4: Evaluate soil chemistry, composition, and physicochemical properties affecting environmental quality.

CLO5: Assess geochemical processes and environmental issues related to pollution and resource management.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Fundamental of Environmental Chemistry: Elements, Chemical bonding, chemical reactions and equations, Organic functional groups, classes of organic compounds, Free radical reactions, catalytic processes, acid base reactions, solutions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydro carbons, radio-nuclides.	Lecture-based teaching, ICT-enabled learning, Concept mapping, Inquiry-based learning, Self-directed learning	CO1
II	Green Environmental Chemistry & Issues: Principles- tools of green chemistry- alternative feed stocks starting materials, alternative reagents, alternative solvents, alternative products and alternative catalysis, Introduction- ecological and carbon foot prints- polluters pay principle- consumerism- sustainable mining- urban forestry green buildings- green building practices- approaches to green computing.	Problem-based learning (PBL), Collaborative learning, Research-oriented learning, Flipped classroom approach	CO2, CO5
III	Environmental Segments: Lithosphere, atmosphere, hydrosphere and biosphere. Lithosphere- Rocks and Minerals. Principles of weathering of rocks, processes, effects of physical, chemical and biological factors, Physical Geology: Geological work of wind, Running water, Underground water, Glaciers. Drainage systems and patterns. Structural Geology: Dip and Strike, Folds, Faults, Joints, Unconformity, Overlap. Mountains.	Lecture-based teaching, Field-based/experiential learning, ICT-enabled learning, Inquiry-based learning, Collaborative learning	CO3

IV	Soil Chemistry & Soil Composition: Organic & Inorganic, physical, chemical and biological properties, cation exchange capacity, soil pH, environmental properties of soils, leaching and erosion and conservation, reactions with acids and bases, geochemical reactions that neutralize acidity-biological process that neutralize acidity – salt affected soils- trace metals in soils. **Concept of zero budget farming.**	Laboratory-based learning, Data analysis exercises, Research-oriented learning, Reflective practices	CO4, CO5

- **(*) Learning Pedagogies/Methods**

  Notes:
  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.
  (2) Acronyms/abbreviations of the terms can be placed in the above table.

  (a) Classroom Lecture (CL)
  (b) Seminars (Student-led and Faculty-moderated)
  (c) Micro-Projects/Mini Research Tasks
  (d) Industrial Visit/Field Visit/Institutional Visit
  (e) Problem-Based Learning (PBL)
  (f) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (g) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (h) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (i) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (j) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (k) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30)

(a) Quiz
(b) Assignment
(c) Seminar/Presentation
(d) Group Task
(e) Attendance

b. Internal Summative Assessment (20)

(a) Mid-Term
(b) External Assessment (50)
(c) End-Term

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M.Sc. Environmental Science SEMESTER I

(B) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	CO1	30	1	1	12	14
II	CO2, CO5	32	1	1	10	12
III	CO3	28	1	1	10	12
IV	CO4, CO5	30	1	1	12	14
		120	**04**	**04**	**34**	**50**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	2	2	2	2	1	–	1	–	2	2
CLO2	3	2	2	1	–	–	–	–	2	1
CLO3	2	3	2	2	1	1	–	–	3	2
CLO4	2	2	3	2	2	1	1	1	3	3
CLO5	–	–	–	–	–	–	–	–	–	–

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Environmental Chemistry	A.K. De	1987	Wiley Eastern Limited
2	Environmental Chemistry	C. Baird	2001	Hopkins Press
3	Introduction to Green Chemistry	V. Kumar	2000	Narosa Publications

4	Environmental Chemistry	S.E. Manahan	Not specified	Cambridge University Press
5	Green Chemistry	Rashmi Sanghi, M.M. Srivastava	Not specified	Narosa Publishing House
6	Fundamentals of Geology	A.B. Roy	2002	Narosa Publications
7	Green Chemistry	Sanghi & Srivastava	2000	Narosa Publications
8	Environmental Chemistry	B.K. Sharma, H. Kaur	Not specified	Goel Publishing House, Meerut
9	General Geology	P. Singh	2002	Oxford Publications
10	Environmental Science	A. Turk, J. Turk, J.T. Wittes, R.E. Wottes	1978	W.B. Saunders Company, Philadelphia
11	Principles of Environmental Sciences	K.E.F. Watt	1973	McGraw Hill Book Company

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Web link
1	NPTEL Courses on Environmental Chemistry and Geology	https://nptel.ac.in
2	US Geological Survey (USGS) – Earth Science and Geology Resources	https://www.usgs.gov
3	EPA Green Chemistry and Environmental Chemistry Resources	https://www.epa.gov/greenchemistry
4	Soil Science Society of America – Soil and Environmental Resources	https://www.soils.org

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M.Sc. Environmental Science SEMESTER I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2T01NCENS04**	Practicals based on Environmental Microbiology and Air Pollution and Climate Change	0-8-0	**120**	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Demonstrate understanding of environmental toxicology concepts, including bioassay techniques and LC□□ determination for assessing toxicity in biological systems.

CLO2: Apply knowledge of meteorological instruments to measure and interpret environmental parameters such as temperature, humidity, pressure, and wind velocity.

CLO3: Analyze the effects of environmental pollutants (e.g., herbicides, heavy metals) on biological systems using experimental and analytical methods.

CLO4: Operate and interpret results from advanced analytical instruments such as UV-Visible Spectrophotometer, GC-MS, AAS, ICP-MS, FTIR, XRD, and related techniques.

CLO5: Utilize statistical tools and graphical methods (mean, median, ANOVA, regression, etc.) for data analysis and interpretation in environmental studies.

CLO6: Apply environmental software tools and ergonomic assessment methods to evaluate environmental and occupational health risks.

Practical Content	Learning Pedagogies*	CLO(s)
1. Estimate water availability as limiting factor for plant growth 2. Study CO□ concentration as a limiting factor in photosynthesis 3. Determination of light penetration and DO of surface water 4. Interactions between organisms, productivity of phytoplankton by chlorophyll method (biomass) and Light and dark bottle method and Macrophyte productivity 5. Determination of total and fecal coliform in water and Most Probable Number 6. Phytoplankton measurement by micrometry 7. Analysis of Salinity of marine water sample 8. Estimate Particulate Matters from air sample 9. Estimate Hydrocarbons from air sample 10. Estimate NOx from air sample 11. Estimate SOx from air sample 12. Calculation of Carbon Footprint for Individual / Household Electricity / Institutional 13. Estimate carbon Sequestration by trees 14. Prepare Carbon Reduction Scenario Modeling 15. Prepare a case study on recent air pollution and disaster episodes- Global and regional	Demonstration-based, Laboratory Teaching, Hands-on Practical / Experimental Learning, Field-based Learning, Analytical Learning, Problem-solving, Case Study, Application-based Learning	CO1 to CO6

- **(*) Learning Pedagogies/Methods**

Notes:
(1) The following list is suggestive. Any other learning pedagogies relevant to discipline- specific requirements can be added.
(2) Acronyms/abbreviations of the terms can be placed in the above table.
(a) Interactive Classroom Lecture
(b) Classroom Lecture (CL)
(c) Seminars (Student-led and Faculty-moderated)
(d) Micro-Projects/Mini Research Tasks
(e) Industrial Visit/Field Visit/Institutional Visit
(f) Problem-Based Learning (PBL)
(g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
(h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
(i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
(j) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
(k) (m)Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
(n) Inquiry-Based Learning
(o) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

(A) Internal Assessment

a. Internal Formative assessment (30)
(a) Journal Evaluation
(b) Method of working
(c) Attendance

b. Internal Summative Assessment (20)
(a) Mid-Term
(b) Viva-Voce

(B) Weightage of Learning Efforts for External Assessment

Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
		Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
CO1, to CO6	120	04	04	34	50

(C) CLOs – PLOs Matrix

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	2	3	2	-	-	1	-	-	-
CLO2	3	3	2	2	-	-	1	-	-	-
CLO3	3	2	3	3	2	-	2	-	-	-
CLO4	2	3	3	2	-	-	2	-	-	-
CLO5	3	2	3	3	2	-	3	-	-	-
CLO6	2	3	3	3	2	2	3	2	1	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Environmental Science	Erach Bharucha	Latest	Universities Press
2	Fundamentals of Ecology	Eugene P. Odum	5th Edition	Cengage Learning
3	Standard Methods for the Examination of Water and Wastewater	APHA	Latest	APHA
4	Environmental Chemistry	A.K. De	Latest	New Age International
5	Air Pollution	K. Wark & C.F. Warner	Latest	Harper Collins
6	Principles of Environmental Engineering and Science	Mackenzie L. Davis	Latest	McGraw Hill
7	Introduction to Environmental Engineering	Gilbert M. Masters	Latest	Pearson
8	Ecology and Environment	P.D. Sharma	Latest	Rastogi Publications

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	United States Environmental Protection Agency – Resources on air pollution, water quality, carbon footprint, and environmental monitoring	https://www.epa.gov
2	World Health Organization – Guidelines on water quality, air pollution, and environmental health	https://www.who.int
3	National Aeronautics and Space Administration – Climate change, carbon cycle, and environmental data resources	https://earthdata.nasa.gov
4	Food and Agriculture Organization – Resources on ecosystem productivity, carbon sequestration, and environmental sustainability	https://www.fao.org

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

Course Type	Course Code	Course Title	Teaching-Learning Scheme L-P-T	Total Notional Hours	Course credits
DSC	**P2T01NCENS05**	Practicals based on Environmental Chemistry and Geology and Introduction to Sustainable Development	0-8-0	120	04

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Demonstrate the preparation and standardization of chemical solutions (normality, molarity, percentage solutions) used in environmental and laboratory analysis.

CLO2: Analyze soil properties such as water holding capacity, particle density, bulk density, moisture content, porosity, and organic carbon using standard experimental methods.

CLO3: Apply environmental chemistry techniques for the treatment and analysis of samples, including dye removal using biosorbents and preparation of eco-friendly indicators.

CLO4: Evaluate sustainable practices through preparation of biodiesel and comparison of synthetic detergents with bio-based cleaners.

CLO5: Interpret geographical and environmental data using geological maps and land-use mapping techniques.

CLO6: Conduct field-based studies in forests, coastal regions, and wetlands, and prepare analytical reports based on observations and environmental assessments**.**

Practical Content	Learning Pedagogies*	CLO(s)
1. Preparation and Standardization of solutions and reagents- Normal, Molar, percentage, solutions, working solution 2. Determination of Water holding capacity from soil sample 3. Determination of particle density from soil sample 4. Determination of bulk density from soil sample 5. Determination of moisture content and porosity from soil sample 6. Determination of organic carbon from soil sample 7. Preparation of Biodiesel from Vegetable Oil 8. Study of Geological maps and preparation of land use maps 9. Removal of dye from water using low-cost biosorbents 10. Preparation of eco-friendly pH indicator from flowers/leaves 11. To compare synthetic detergent and bio-based cleaner 12. Field visits to Forest, coastal environments and wetlands and prepare a report and submit at the time of university Exam	Demonstration-based, Laboratory Teaching, Hands-on Practical / Experimental Learning, Field-based Learning, Analytical Learning, Problem-solving, Project-based Learning, Application-based Learning	CO1 to CO6

- **(*) Learning Pedagogies/Methods**

  Notes:
  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline- specific requirements can be added.
  (2) Acronyms/abbreviations of the terms can be placed in the above table.
  (a) Interactive Classroom Lecture
  (b) Classroom Lecture (CL)
  (c) Seminars (Student-led and Faculty-moderated)
  (d) Micro-Projects/Mini Research Tasks
  (e) Industrial Visit/Field Visit/Institutional Visit
  (f) Problem-Based Learning (PBL)
  (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
  (j) Simulation and Role-Play (Academic, Professional, or Policy-based Scenarios)
  (k) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars) (m)Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (n) Inquiry-Based Learning
  (o) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

  (A) Internal Assessment

  a. Internal Formative assessment (30)
  (a) Quiz
  (b) Assignment
  (c) Seminar/Presentation
  (d) Group Task
  (e) Attendance

  b. Internal Summative Assessment (20)
  (a) Mid-Term
  (B) External Assessment (50)
  (a) End-Term

(B) Weightage of Learning Efforts for External Assessment

Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
		Remember (R)	Understanding (U)	Application/ Analyze & above (A)	
CO1 to CO6	120	04	04	34	50

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	**PLO2**	**PLO3**	**PLO4**	**PLO5**	**PLO6**	**PLO7**	**PLO8**	**PLO9**	**PLO10**
CLO1	3	3	2	2	-	-	1	-	-	-
CLO2	3	2	3	3	1	-	2	-	-	-
CLO3	3	2	3	3	2	-	2	-	-	-
CLO4	2	3	3	2	2	1	3	-	-	-
CLO5	2	3	3	3	2	1	3	-	-	-
CLO6	2	2	3	3	2	2	3	2	1	1

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Soil Science and Management	Edward J. Plaster	5th Edition, 2014	Delmar Cengage
2	Methods of Soil Analysis	American Society of Agronomy	3rd Edition, 1996	ASA
3	Environmental Chemistry	A.K. De	7th Edition, 2016	New Age International
4	Introduction to Environmental Engineering	Gilbert M. Masters	2nd Edition, 1991	Pearson
5	Biofuels Engineering Process Technology	Caye Drapcho	1st Edition, 2008	McGraw Hill
6	Environmental Science	Erach Bharucha	3rd Edition, 2013	Universities Press
7	Principles of Environmental Engineering	Mackenzie L. Davis	3rd Edition, 2019	McGraw Hill
8	Soil and Water Conservation Engineering	R. Suresh	4th Edition, 2013	Standard Publishers

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	Soil analysis methods (water holding capacity, bulk density, particle density, moisture, organic carbon)	https://www.fao.org/soils-portal
2	Environmental chemistry and water treatment (dye removal, detergents, pH indicators)	https://www.epa.gov/environmental-topics
3	Biodiesel preparation and renewable energy resources	https://mnre.gov.in/bio-energy
4	Geological maps, land use mapping and environmental studies	https://www.usgs.gov

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	**P2T01NCENS06**	Introduction to Sustainable Development	2-0-1	**60**	02

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

CLO1: Explain the concepts, principles, and dimensions of sustainable development.

CLO2: Describe global frameworks, summits, and indicators related to sustainable development.

CLO3: Analyze major global challenges affecting sustainability including climate change and resource depletion.

CLO4: Evaluate environmental, social, and economic issues and their interrelationships.

CLO5: Assess policies, governance, and management strategies for sustainable development.

CLO6: Apply sustainable approaches for ecosystem restoration and community-based development practices.

Unit	Course Content	Learning Pedagogies*	CO(s)
I	Introduction to sustainable development: Concept of sustainable development, Rio earth Summit (1992), Brundtl and commission report, scheme of sustainability: economic, social, environmental; indicators of sustainable development and its selection criteria, Agenda 21 World Summit on Sustainable Development, Local agenda 21 (Earth Summit 2002), planning (for Sustainable Development). Millennium development goals and its recent status (global, Indian), approaches to sustainable development: natural resource management, capacity building, Ecosystem concept in space and time; Ecosystem level processes and landscape level processes; the concept of sustainable development temporal and spatial dimensions.	Lectures, ICT tools, problem- solving exercises	CO1, CO2
II	Global challenges of sustainable development: poverty, pollution, population, finance for sustainable development, health, nutrition, sanitation, energy crisis, disasters, desertification, biopiracy etc. Currencies for evaluations of sustainable development-Biophysical measurements; Environmental degradations and conservation issues; Global change and sustainability issues: Climate change, biological invasion, bio-diversity concerns. Human resource	Lectures, ICT tools, problem- solving exercises	CO3, CO4, CO5, CO6

	development, pollution management, green policy development, good governance and recycling, reuse and recovery. Ecosystem and social processes in: (a) Rehabilitation of degraded rural landscape, (b) Rehabilitation of unbalanced soils, (c) Rehabilitation of specialized habitats, e.g. water bodies, mangroves; (d) Mined area rehabilitation participatory research and education environmental decision making with people initiates.		

- **(*) Learning Pedagogies/Methods**

  Notes:

  (1) The following list is suggestive. Any other learning pedagogies relevant to discipline- specific requirements can be added.

  (2) Acronyms/abbreviations of the terms can be placed in the above table.

  (a) Classroom Lecture (CL)
  (b) Seminars (Student-led and Faculty-moderated)
  (c) Micro-Projects/Mini Research Tasks
  (d) Industrial Visit/Field Visit/Institutional Visit
  (e) Problem-Based Learning (PBL)
  (f) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
  (g) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
  (h) Experiential Learning (Community Engagement, Internship-linked Activities, Practice- based Tasks)
  (i) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
  (j) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
  (k) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

  (A) Internal Assessment

  a. Internal Formative assessment (15)

  (a) Quiz
  (b) Assignment
  (c) Seminar/Presentation
  (d) Group Task
  (e) Attendance

  b. Internal Summative Assessment (10)

  (a) Mid-Term
  (b) External Assessment (25)
  (c) End-Term

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NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. Environmental Science SEMESTER I

(A) Weightage of Learning Efforts for External Assessment

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Application/ Analyse & above (A)	
I	**CO1, CO2**	30	1	1	12	14
II	**CO3, CO4, CO5, CO6**	32	1	1	10	12
		62	**02**	**02**	**22**	**26**

- **Assessment and Evaluation**

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity,	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

- **CLOs – PLOs Matrix**

CLO	PLO									
	PLO1	PLO2	PLO3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO10
CLO1	3	2	1	–	–	–	–	–	3	2
CLO2	2	2	2	1	–	–	–	–	2	2
CLO3	2	2	3	2	1	–	–	–	2	2
CLO4	2	2	3	3	2	1	–	–	2	2
CLO5	2	3	2	3	2	2	1	–	2	3
CLO6	2	2	2	3	2	2	2	1	2	2

Values to **CLO-PLO** matrix are assigned **by judging the importance of the particular CLO** in relation to the **PLOs**.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

- **Suggested Learning Materials Books:**

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Strategic Environmental Analysis: A New Planning Framework for Sustainable Development	AID Environment	1997	AIDEnvironment, Amsterdam
2	Governance for Sustainable Development: A Southern Perspective	T. Banuri, J. Holmberg	1992	IIED, London
3	Strategies for Sustainability: Asia	J. Carew-Reid (Ed.)	1997	IUCN in association with Earthscan, London
4	The Terroir Approach to Natural Resource Management: Panacea or Phantom? – the Malian Experience	T. Degnbol	1996	International Development Studies, Roskilde University, Denmark
5	Sustainable Development Strategies: A Resource Book	Earthscan	2002	OECD (Paris) & UNDP (New York)
6	Investment in Sustainable Development: The Public–Private Interface (in *The Future is Now*, Vol. 2)	M. Grieg-Gran	2001	IIED, London

- **Online Resources (Open Source)**

Sr. No.	Description of Resource(s)	Weblink
1	United Nations Sustainable Development Goals (SDGs) Portal	https://sdgs.un.org
2	UNEP Sustainable Development and Environment Resources	https://www.unep.org
3	World Bank Data on Sustainability, Poverty and Development	https://www.worldbank.org
4	NITI Aayog SDG India Index and Reports	https://www.niti.gov.in