॥ सा विद्या या विमुक्तये ॥

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

'ज्ञानतीर्थ', विष्णुपुरी, नांदेड – ४३१ ६०६ (महाराष्ट्र राज्य) भारत

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

'Dnyanteerth', Vishnupuri, Nanded - 431 606 (Maharashtra State) INDIA

Established on 17th September, 1994, Recognized By the UGC U/s 2(f) and 12(B), NAAC Re-accredited with'B++' grade

स्वामी रामानंद तीर्थ मराठवाडा विद्यापीठ, नांदेड

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विज्ञान व तंत्रज्ञान विद्याशाखे अंतर्गत राष्ट्रीय शैक्षणिक धोरण २०२० च्या अनुषंगाने शैक्षणिक वर्ष २०२३–२४ पासून संलग्न महाविद्यालये व विद्यापीठ संकुलांत पदव्युत्तर पदवी प्रथम वर्ष आणि विद्यापीठ संकुले व न्यू मॉडेल डिग्री कॉलेज मध्ये पदवी प्रथमवर्ष अभ्यासक्रम लागू करण्याबाबत.

प रि प त्र क

या परिपत्रकान्वये सर्व संबंधितांना कळविण्यात येते की, शासन निर्णय क्र. एनईपी २०२०/प. क्र. ०९/विशि–३/शिकाना, दिनांक २० एप्रिल २०२३ व शासन पत्र. क्र एनईपी २०२०/प. क्र. ०९/विशि–३, दिनांक १६ जून २०२३ अन्वये सूचित केल्यानुसार राष्ट्रीय शैक्षणिक धोरण २०२०च्या अनुषंगाने दिलेल्या आराखडया नुसार दिनांक १६ जून २०२३ रोजी संपन्न झालेल्या मा. विद्यापरिषदेच्या बैठकीत ऐनवेळचा विषय क्र. ०५/५६–२०२३ अन्वये मान्यता दिल्यानुसार प्रस्तुत विद्यापीठाच्या विज्ञान व तंत्रज्ञान विद्याशाखा अंतर्गत खालील पदव्युत्तर पदवी अभ्यासक्रम (AICTE, PCI, BCI, CoA, NCTE) इ. सारख्या नियमक संस्थाची मान्यता आवश्यक असलेले अभ्यासक्रम वगळून) संलग्न महाविद्यालये, विद्यापीठ परिसर व उपपरिसर संकुलांमध्ये आणि पदवी प्रथम वर्ष अभ्यासक्रम विद्यापीठ परिसर व उपपरिसर संकुले व विद्यापीठ संचलित न्यू मॉडेल डिग्री कॉलेज, हिंगोली येथे शैक्षणिक वर्ष २०२३–२४ पासून लागू करण्यात येत आहे.

1) M.Sc. Bioinformatics (1st Year) – Sub-Campus School Latur
2) M.Sc. Mathematics (1st Year) – Campus School
3) M.Sc. Zoology (1st Year) - Campus School
4) M.Sc. Environmental Science (1st Year) –Campus School
5) M.Sc. Environmental Science (1st Year) - Affiliated colleges
6) M.Sc. Information Technology (1st Year) - Affiliated colleges
7) M.Sc. Software Engineering (1st Year) - Affiliated colleges

सदरील परिपत्रक व अभ्यासक्रम प्रस्तुत विद्यापीठाच्या **www.srtmun.ac.in** या संकेतस्थळावर उपलब्ध आहेत. तरी सदरील बाब ही सर्व संबंधितांच्या निदर्शनास आणून द्यावी, ही विनंती.

'ज्ञानतीर्थ' परिसर,
विष्णुपुरी, नांदेड – ४३१ ६०६.
जा.क्र.:शै–१/एनइपी२०२०/S&T/अक/२०२३–२४/133

दिनांक : ०७.०७.२०२३.

सहा.कुलसचिव
शैक्षणिक (१–अभ्यासमंडळ) विभाग

प्रत : १) मा. कुलगुरू महोदयांचे कार्यालय, प्रस्तुत विद्यापीठ.
३) मा. आधिष्ठाता, विज्ञान व तंत्रज्ञान विद्याशाखा, प्रस्तुत विद्यापीठ.
४) मा. संचालक, परीक्षा व मुंल्यमापन मंडळ, प्रस्तुत विद्यापीठ.
१) मा. प्राचार्य, सर्व संबधित संलग्नित महाविद्यालये, प्रस्तुत विद्यापीठ.
२) मा. संचालक, सर्व संकुले परिसर व उपपरिसर, प्रस्तुत विद्यापीठ
५) सिस्टीम एक्सपर्ट, शैक्षणिक विभाग, प्रस्तुत विद्यापीठ. याना देवून कळविण्यात येते की, सदर परिपत्रक संकेतस्थळावर प्रसिध्द करण्यात यावे.

STRUCTURE AND SYLLABUS OF TWO-YEAR POST GRADUATE PROGRAM IN

SCIENCE & TECHNOLOGY

(R-2023)

UNDER

NATIONAL EDUCATION POLICY (NEP 2020)

In

SUBJECT: ENVIRONMENTAL SCIENCE

FACULTY OF SCIENCE AND TECHNOLOGY

Program Code: SES-S-ENV-PG

M. Sc. First Year
UNIVERSITY CAMPUS

SCHOOL OF EARTH SCIENCES

SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

With Effect from June 2023

Introduction:

The National Education Policy 2020 (NEP 2020) is formulated to revamp education system and lay down road map for new India. This policy is framed based on the fundamental pillars of access, equity, quality, affordability, and accountability and seeks to transform India into a thriving knowledge society and a global knowledge superpower.

Some of the important features of National Education Policy are Increasing GER in higher education, Holistic and multidisciplinary education with multiple entry/exit options, Establishment of academic bank of credit, Setting up of multidisciplinary education and research Universities and National Research Foundation, Expansion of open and distance learning to increase gross enrolment ratio, Internationalization of education, Motivated, energized and capable faculty, Online and digital education and Effective governance and leadership.

As per the National Education Policy, the Government of Maharashtra has proposed a model curriculum framework and an implementation plan for the State of Maharashtra. It is to suggest and facilitate the implementation of schemes and programs, which improve not only the level of academic excellence but also improve the academic and research environment in the state. The proposed curriculum framework endeavours to empower the students and help them in their pursuit for achieving overall excellence.

In view of NEP priority and in-keeping with its vision and mission, process of updating the curriculum is initiated and implemented in SRTM University at UG and PG level from the academic year 2023-2024.

Keeping in mind, BOS in Environmental and Earth Science has prepared the curriculum to ensure up-to-date level of understanding of Environmental Science. Studying Environmental Science prepares the students for their career working either in educational institutions or industries in which they can be directly involved in the teaching, research and development. Also, to ensure uniform curriculum and its quality at PG level, curriculum of different Indian Universities, syllabus of NET, SET, MPSC, UPSC, and the UGC model curriculum are referred to serve as a base in updating the same.

The comments or suggestions from all teachers, students and other stakeholders are welcome for upbringing this curriculum.

Salient Features:

The syllabus of M Sc Environmental Science has been framed to meet the requirement of Choice Based Credit System under NEP 2020. The courses offered here in will train and orient the students in the specific fields of Environmental Science.

Core Courses deals with…

Apart from the Fundamental and applied Core Courses, the Discipline Specific Elective Courses deals with Water & Wastewater Treatment Technology, Applied Microbiology, Air Pollution etc.

This would help students to lay a strong foundation in the field of Environmental Science.

Overall, after completion of this course, students will also acquire fundamental knowledge and applications in Environmental Science and also understand that Environmental Science is an integral part of the human life and developments.

Program Educational Objectives:

The Objectives of this program are:

PEO1: To expose themselves to the diversity amongst life forms and their interactions.

PEO2: To make aware of natural resources and environment and the importance of conserving the same.

PEO3: To update curriculum by introducing recent advances in the subject and enable the students to face NET, SET, UPSC and other competitive examinations successfully.

PEO4: To train and orient the students so as to develop human resource for the educational institutes, industries and other organizations.

PEO5: To develop specific skills amongst students for self-employability through the development of their own enterprises.

PEO6: To develop ability for the application of the acquired knowledge in the fields of life so as to make our country self-reliant and self-sufficient.

Program Outcomes:

The Outcomes of this program are:

PO1: This program will expose the students to the diversity amongst different life forms.

PO2: This program shall also make aware the students about natural resources and environment and the importance of conserving the same.

PO3: This will provide updated curriculum with recent advances in the subject and enable the students to face NET, SET, UPSC and other competitive examinations successfully.

PO4: This program shall train and orient the students so as to develop human resource for the educational institutes, industries and other organizations.

PO5: This will also develop specific skills amongst students for self-employability through the development of their own enterprises.

PO6: This shall develop ability in the students for the application of the acquired knowledge in the fields of life so as to make our country self-reliant and self-sufficient.

Prerequisite:

The students seeking admission to M Sc Environmental Science should have passed Graduation in sciences. The optional courses are offered to the students registered for graduate and post-graduate programs. Such students should have the basic knowledge of Environmental Science and willing to gain additional knowledge in the field of Environmental Science.

Admissions to this program are given as per the University rules.

Dr Arjun Bhosle

Chairman, BOS Environmental & Earth Science

Swami Ramanand Teerth Marathwada University, Nanded.

bhoslearjunenvisci@gmail.com

Details of the Board of Studies Members in the subject Environmental Science under the Faculty of Science & Technology, S.R.T.M. University, Nanded.

Dr. Arjun Bapurao Bhosle **Chairman** School of Earth Sciences, This University Mob	Dr. Vasant Madhav Wagh **Member** School of Earth Sciences, This University Mob
Dr. Sudhir Vishwambhar Shivanikar **Member** Netaji Subhashchandra Bose College, Nanded	Dr. Raju Kashinath Narkhede **Member** Maharashtra Udaygiri Mahavidyalaya, Udgir, Tq. Udgir Dist. Latur
Dr. Kedar Ramkrishna Solunke **Member** Indira Gandhi Senior College, CIDCO, Nanded	Dr. Vinod K Mukke **Member** Shivneri Mahavidyalaya, Shirur Anantpal, Tq. Shirur Anantpal Dist. Latur
Dr. Jayprakash Manoharrao Patwari **Member** Maharashtra Udaygiri Mahavidyalaya, Udgir, Tq. Udgir Dist. Latur	Dr. Rajkumar ``` Indira Gandhi Senior College, CIDCO, Nanded
Dr. Satish Sudhakarrao Patil **Member** Dr. B A Marathwada University, Aurangabad (Chh. Sambhajinagar)	Dr. Ravindra S Gavali **Member** Centre for Natural Resource Management, (CNRMCC & DM) National Institute of Rural Development & Panchayati Raj, Rajendra Nagar, Hyderabad
Dr. Pravin U Meshram **Member** Sevadal Mahila Mahavidyalaya & Research Academy, Sakkardara Square, Umrer Road, Nagpur- 440009	
As Per MPUA u/s 40(2)(d)(E Invitee Member	
Sonkamble Soloni Ramkishan (UG Student) C/o Maharashtra Udaygiri Mahavidyalaya, Udgir, Tq. Udgir Dist. Latur	Madiha Jabeen Gulam (PG Student) Netaji Subhashchandra Bose College, Nanded

M. Sc. First Year Semester I (Level 6.0)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SENVC401	Ecology and Evolution	04	--	**04**	04	--
	SENVC 402	Air and Water Pollution	04	--	**04**	04	--
	SENVC403	Energy Resource Management	04	--	**04**	04	--
Elective (DSE)	SENVE401 SENVE403	Environmental Geosciences OR Current Environmental Issues	03	--	**03**	03	--
Research Methodology	SVECR401	Research Methodology	03	--	**03**	03	
DSC Practical	SENVP401	Practical Based on 401	--	01	**01**	--	02
	SENVP402	Practical Based on 402	--	01	**01**	--	02
	SENVP403	Practical Based on 403	--	01	**01**	--	02
DSE Practical	SENVE402 SENVE404	Elective Lab OR Elective Lab	--	01	**01**	--	02
Total Credits			**18**	**04**	**22**	**18**	**08**

M. Sc. First Year Semester I (Level 6.0)

Examination Scheme

[20% Continuous Assessment (CA) and 80% End Semester Assessment (ESA)]

Subject	Course Code	Course Name	Theory				Practical		Total Marks
			Continuous Assessment (CA)			ESA			
			Test I	Test II	Avg of (T1+T2)/2	Total	CA	ESA	
Major	SENVC401	Ecology and Evolution	20	20	20	80	--	--	100
	SENVC 402	Air and Water Pollution	20	20	20	80	--	--	100
	SENVC403	Energy Resource Management	20	20	20	80	--	--	100
Elective (DSE)	SENVE401 SENVE402	Environmental Geosciences OR Current Environmental Issues	15	15	15	60	--	--	75
Research Methodology	SVECR401	Research Methodology	15	15	15	60	--	--	75
DSC Practical	SENVP401	Practical Based on 401	--	--	--	--	05	20	25
	SENVP402	Practical Based on 402	--	--	--	--	05	20	25
	SENVP403	Practical Based on 403	--	--	--	--	05	20	25
DSE Practical	SENVE403 SENVE404	Elective Lab OR Elective Lab	--	--	--	--	05	20	25

M. Sc. First Year Semester II (Level 6.0)

Teaching Scheme

Subject	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/ week)	
			Theory	Practical	Total	Theory	Practical
Major	SENVC451	Environmental Chemistry and Toxicology	04	--	**04**	04	--
	SENVC452	Environmental Analytical techniques	04	--	**04**	04	--
	SENVC453	Environmental Microbiology	04	--	**04**	04	--
Elective (DSE)	SENVE451 SENVE453	Environmental Economics OR Biodiversity and Wildlife Management	03	--	**03**	03	--
On Job Training / Field Work / Case Study	SENVO414	ON Job Training	03	--	**03**	03	
DSC Practical	SENVP451	Practical Based on 451	--	01	**01**	--	02
	SENVP452	Practical Based on 452	--	01	**01**	--	02
	SENVP453	Practical Based on 453	--	01	**01**	--	02
DSE Practical	SENVE452 SENVE454	Elective Lab OR Elective Lab	--	01	**01**	--	02
Total Credits			**18**	**04**	**22**	**18**	**08**

M. Sc. First Year Semester II (Level 6.0)

Examination Scheme

[20% Continuous Assessment (CA) and 80% End Semester Assessment (ESA)]

Subject	Course Code	Course Name	Theory				Practical		Total Marks
			Continuous Assessment (CA)			ESA			
			Test I	Test II	Avg of (T1+T2)/2	Total	CA	ESA	
Major	SENVC451	Environmental Chemistry and Toxicology	20	20	20	80	--	--	100
	SENVC452	Environmental Analytical techniques	20	20	20	80	--	--	100
	SENVC453	Environmental Microbiology	20	20	20	80	--	--	100
Elective (DSE)	SENVE451 SENVE453	Environmental Economics OR Biodiversity and Wildlife Management	15	15	15	60	--	--	75
On Job Training / Field Work / Case Study	SENVO414	ON Job Training	15	15	15	60	--	--	75
DSC Practical	SENVP451	Practical Based on 451	--	--	--	--	05	20	25
	SENVP452	Practical Based on 452	--	--	--	--	05	20	25
	SENVP453	Practical Based on 453	--	--	--	--	05	20	25
DSE Practical	SENVE452 SENVE454	Elective Lab OR Elective Lab	--	--	--	--	05	20	25

SENVC401	Ecology and Evolution

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVC401	Ecology and Evolution	04	--	04	--	04

Course Structure: ***Major 1 - Teaching Scheme***

Major 1 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVC401	Ecology and Evolution	20	20	20	80	--	--	100

SENVC401: Ecology and Evolution *(Major 1) Curriculum Details*

Course Prerequisite:

1. Basic knowledge about living and nonliving components of environment and their interactions,
2. Basic knowledge climatic conditions and flora and fauna of particular place.

Course Objectives:

1. This course aims to enable the students to gain knowledge about how the living and non living components are related to each other
2. Identify components of ecosystem and their relationship that decides their behavioural and special pattern.
3. This course aims to enable the students to gain knowledge about different theories about evolution.

Course Outcomes: On successful completion of the module, students should be capable of:

1. Identifying various ecosystems and their characteristics, functions and interactions.
2. Identifying various aspects of population ecology, community ecology, Concept of biodiversity, its Importance measurement methods and its status in India
3. Knowledge of Evolutionary theories.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Fundamental Concepts**	**10**
	1.1	Abiotic and biotic components; scales (population, species, community, ecosystems, biomes); niches and habitats.	
	1.2	Population Ecology: Population growth rates (density dependent/independent);	
	1.3	Metapopulation ecology (colonization, persistence, extinction, patches, sources, sinks); age-structured populations.	
	1.4	Interactions: Types (mutualism, symbiosis, commensalism, competition, parasitism, predation, etc);	

2.0		**Ecosystem and Community Ecology**	**20**
	2.1	ecophysiology (physiological adaptations to abiotic environment); prey-predator interactions (Lotka-Volterra equation etc)	
	2.2	Community Ecology: Community assembly, organization and succession; species richness, evenness and diversity indices,	
	2.3	species-area relationships; theory of island biogeography	
	2.4	Ecosystems Structure and Function: trophic levels and their interactions; nutrient cycles; primary and secondary productivity	
3.0		**Genetics and Evolutionary Biology**	**20**
	3.1	Mendelian inheritance; Gene interaction; Complementation; Linkage, recombination and chromosome mapping; Extra chromosomal inheritance; Microbial genetics - transformation, transduction and conjugation; Horizontal gene transfer and transposable elements; Chromosomal variation; Genetic disorders; Population genetics; Epigenetics; Selection and inheritance; Adaptive and neutral evolution; Genetic drift; Species and speciation.	
	3.2	History of Evolutionary Thought: Lamarckism; Darwinism; Modern Synthesis Fundamentals: Variation; heritability; natural selection; fitness and adaptation; types of selection (Stabilizing, directional, disruptive)	
	3.3	Molecular Evolution and Phylogenetics: Neutral theory; molecular clocks; rates of evolution; phylogenetic reconstruction; molecular systematics Macroevolution: Species concepts and speciation; adaptive radiation; convergence; biogeography	
4.0		**Disease Ecology and Evolution**	**10**
	4.1	Disease Ecology and Evolution: Epidemiology; zoonotic diseases;	
	4.2	antibiotic resistance; vector Control Plant and animal breeding:	
	4.3	Marker assisted breeding; genetic basis of economically important traits	
		Total	**60**

Text Books:

1. Eugene P. Odum, **Fundamentals of Ecology, (**Natraj Publishers, Dehradun)

2. P. S. Verma, V. K. Agarwal, **Principles of Ecology,** (S. Chand and Co. New Delhi)
3. P. D. Sharma, **Environmental Biology,** (Rastogi Publications, Meerut)
4. P. D. Sharma, **Ecology and Environment,** (Rastogi Publications, Meerut)
5. P. K. G. Nair, **Principles of Environmental Biology,** (Himalaya Pub. House, New Delhi)
6. M. P. Arora, **Environmental Biology,** (Himalaya Publishing House, New Delhi)

Reference Books:

1. Robert Leo Smith, **Ecology and Field Biology,** (Harper Collins college publication)
2. H. D. Kumar, **General Ecology,** (Vikas Publishing house, New Delhi)
3. Brij Gopal, N. Bharadwaj, **Elements of Ecology,** (Vikas Publishing house, New Delhi)
4. Bill Freedman, **Environmental Ecology,** (Academic Press, New York)
5. N. Arumugam, **Concepts of Ecology,** (Saras Publication, Kottar, Dist. Kanyakumari)

SENVC 402	Air and Water Pollution

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVC 402	Air and Water pollution	04	--	04	--	04

Course Structure: *Major 2 - Teaching Scheme*

Major 2 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVC 402	Air and Water Pollution	20	20	20	80	--	--	100

SENVC 402: Air and Water pollution *(Major 2) Curriculum Details*

Course pre-requisite:

1. This course may opt by M.Sc. students from Environmental Science subject to understand the air and water pollution sources and impacts.
2. Also, air and water pollution control measures/technologies will help to control air and water pollution problems.

Course objectives:

- The aim of this paper is to provide skills and an improved understanding of air and water pollution problems and their control measures.
- To know the Air and water pollution legislation and their operations at national level.
- To study and analyse the impacts of air and water contaminants (energy, resources/waste) within the built, urban, agricultural and natural environments.

Course outcomes:

- Analyse and interpret the air and water pollution problems.
- Students can be able to understand the sources and impacts of air and water pollutants on living and non-living things.
- Students are able to think critically and contribute to research in solving contemporary air and water pollution problems with professional and ethical accountability.
- It is useful for politicians, decision makers, local bodies, Bureaucrats etc for effective management of pollution problems.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Air Pollutants and effects**	**15**
	1.1	Introduction of Air pollutants, primary and secondary pollutants, Natural contaminants: Aerosols, Dust, Smoke, Mist, Fog, Fumes, Particulate matter (PM), Suspended particulate matter (SPM), Respirable suspended particulate matter (RSPM), Fly ash, Photochemical smog;	
	1.2	Gaseous air pollutants: Sulphur dioxide, Carbon monoxide, Radioactive gases etc.	
	1.3	Natural sources: Volcano, Accidental fires in forests, Dust storms, Combustion, Acid manufacturing, Mobile sources, Indoor air pollution, Vehicular emissions etc.	
	1.4	Effects of air pollution on human health, Vegetation, Animals, Material and structure, Long term effects on the planet:, Greenhouse gases, Types of greenhouse gases, Effects, Sources and remedies, Technological options, Kyoto protocol, Ozone depletion, Air pollution standards and indices, Air pollution related case studies	
2.0		**Ambient Air Sampling and control measures**	**15**
	2.1	Air sampling, Particulate matter sampling and analysis: Dust fall measurement, High volume air sampler; Gaseous pollutants sampling and analysis: Carbon monoxide, Ozone, Hydrogen sulphide, etc.	
	2.2	Air pollution control devices principle and working: Gravity settlers, Cyclone separators, Fabric filters, Electrostatic precipitators, Wet scrubbers etc.	
	2.3	Air pollution model: Box model, Gaussian dispersion model, area and line sources. Prediction of effective stack height, physics of plume rise, Atmospheric metrological factors: Wind profiles, turbulent diffusion, topographic effects, stability, inversions, adiabatic lapse rate, plume behavior etc. Air pollution case studies and current issues.	
3.0		**Basics of Water pollution**	**20**
	3.1	Definition, Hydrosphere, Types of water pollutants- physical, chemical, biological. Sources of water pollution- Point sources, non point sources, Natural and Anthropogenic sources, Sewage and domestic waste, Industrial effluent (like Dairy, Sugar, Paper & Pulp, Distillery and food processing,	

		etc.), Agricultural discharges (Fertilizers, Pesticides, Herbicides, etc.), Detergents, Toxic metals, Thermal pollution	
	3.2	Types of pollution- Groundwater pollution, Surface water pollution- Lake water pollution, River water pollution, Eutrophication, Marine pollution, Effect on life.	
	3.3	Classification of pollutants- Inorganic pollutants, organic pollutants, Biological pollutants, sediments, Oxygen demanding waste, DO and BOD interrelationship, Disease causing agents, Radioactive pollutants	
4.0		**Water quality measurement and control measures**	**10**
	4.1	Measurement of water quality parameters: sampling and analysis for pH, EC, turbidity, TDS, hardness, chlorides, salinity, DO, BOD, COD, nitrates, phosphates, sulphates, heavy metals and organic contaminants. Microbiological analysis – MPN. Indian standards for drinking water (IS:10500, 2012).	
	4.2	Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Common effluent treatment plant.	
	4.3	Water pollution case studies and current issues	
		Total	**60**

Text Books:

- Sumit Malhotra, "Air Pollution and Its Control" Pointer publishers, Jaipur
- M. N. Rao, "Air Pollution" Tata McGraw – Hill publishing company, New Delhi.
- B. K. Sharma, H. Kaur, "Air Pollution" Krishna Prakashan media, Meerut.
- B. Henderson, "Pollution of Our Atmosphere" Sellers Adam Hilger Limited, Bristol
- S. K. Agarwal, "Air Pollution**"** A. P. H. Publishing corporation, New Delhi.
- C. S Rao, "Environmental Pollution Control Engineering" Wiley Eastern Ltd., New Delhi, 1996.
- Edward A. Laws, "Aquatic Pollution: An Introductory Text".
- P. K. Goel, "Water Pollution: Causes, Effects and Control".

Reference Books:

- Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, & A. C. Stern, "Fundamentals of Air Pollution", Academic Press, California
- Noel De Nevers, "Air Pollution Control Engineering" Mc-Graw–Hill Intl, New York.
- Arcadio P. Sincero and Gregoria A. Sincero, "Environmental Engineering" Prentice Hall of India, 1999.
- H. Brauer and Y. B. G. Verma, "Air Pollution Control Equipment". Berlin Heidelberg, New York, latest edition

SENVC403	Energy Resource Management

Course Structure: *Major 3 - Teaching Scheme*

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVC 403	Energy Resource Management	04	--	04	--	04

Major 3 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVC 403	Energy Resource Management	20	20	20	80	--	--	100

SENVC403: ***Title (Major 3) Curriculum Details***
Energy Resource Management (4 Credits)

Course pre-requisite:

1. Basic understanding and interest about conventional and non-conventional energy resources.

Course objectives:

- This course will be useful to enhance the knowledge about energy resources in present generation including fundamentals of technology, management, energy conservation and energy security and to make them capable in addressing the nearby energy related issues.
- To determine the role of renewable and non-renewable energy resources and learn different utilities of energy
- To develop new methodologies to tackle problems associated with energy sector.
- To encourage students to develop and promote awareness among the society regarding energy resources and their sustainable utilization.

Course outcomes:

After successful completion of this course, a student should know

- The fundamental knowledge about different types of energy
- Depict the challenges associated with the use of different energy sources and their potential solutions
- To recognize and describe the present state of energy security and its significance.
- They will be acquainted with ideas for reducing energy impacts on the surrounding environment.
- Identify the current developments in sustainable and renewable energy

Curriculum Details: (*There shall be FOUR Modules in each course)*

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction to Energy Resources**	**10**
	1.1	Different forms of Energy	
	1.2	Sources and requirements of Energy	
	1.3	Nonrenewable Energy, Renewable Energy,	
	1.4	Energy and the Environment	
2.0		**Non-Renewable Energy Resources**	**20**
	2.1	Petroleum: Extraction of crude oil, Environmental effects;	
	2.2	Coal: Origin of Coal, Composition of Coal, Types of Coal, Uses of Coal, Coal and the Environment;	
	2.3	Gas: Formation, Sources of natural gas, Natural gas and the Environment;	
	2.4	Nuclear energy: nuclear fission, Energy released in nuclear fission; Nuclear fuel Uranium, Nuclear Power and the Environment.	
3.0		**Renewable Energy Resources**	**20**
	3.1	Solar energy: Solar electricity generation, Solar heaters, Solar dryers, Solar cookers;	
	3.2	Wind energy: Wind Power plants, Wind power potential in India;	
	3.3	Geothermal energy: Sources of geothermal energy, power generation from geothermal energy, Advantages of geothermal energy;	
	3.4	Hydroelectric energy: Micro Hydropower, Hydropower and the Environment; Tidal and Wave Energy: Ocean Thermal Energy Conservation.	
4.0		**Biological Energy Resources**	**10**
	4.1	Bio Fuel: Classes of bio fuel, Sources of bio fuel, Production of bio fuel, Ethanol.	
	4.2	Biodiesel: Introduction, Plant oils used for bio diesel; Production of bio diesel: Vegetable oils as diesel fuels, Manufacturing process for bio diesel, Industrial scale production of bio diesel,	
	4.3	Biomass energy: Wood and wood waste, Biomass and the Environment.	
	4.4	Municipal solid waste, Landfill gas	
		Total	**60**

References: Text books

- Ecoinformatics Volume 5: S. K. Agarwal, A. P. H. Publishing Corporation, New Delhi, 2002.
- Fuels and Bio-fuels: Vijayalaxmi, Meena Devi, Nagendra Prasad, Agrobios (India), Jodhpur, 2007.
- Environmental resource Conservation: S. K. Shukla, P. R. Shrivastava, Commonwealth Publishers, New Delhi, 1992.
- Environmental Science: S. C. Santra, New Central Book Agency, Kolkata, 2005
- Environmental Problems & Solutions: D. K. Asthana & Meera Asthana, S. Chand & Co. New Delhi, 1998
- Environmental Science: Eldon D. Enger, J. Richard Kormelink, B. F. smith, R. J. Smith, WMC Brown Co. Dubuguelowa, 1984
- Environmental Science: Bernard J. Neble, Richard T. Wright, Prentice Hall, New Jersey, USA, 1981
- Non-Conventional Energy Sources: S. N. Kaul, A. R. Bhalerao, R. K. Trivedy, Current Publications, Agra, 2007.

Reference Books.

- Fundamentals of Environmental Science: G. S. Dahliwal, G. S. Sangha, P. K. Ralhan, Kalyani Publishers, New Delhi.
- Environmental Science: Enger Smith, Smith, W. M. C. Brown (Company Publishing)
- Energy Management Handbook, By W.C. Turner, John Wiley and Sons
- S. P. Sukhatme and J K Nayak, **Solar Energy - Principles of thermal collection and storage**, 3rd Ed Tata McGraw-Hill, New Delhi.
- D. Y. Goswami, F. Kreith and J. F. Kreider, **Principles of Solar Engineering**, Taylor and Francis, Philadelphia, 2000.
- Sunggyu Lee, **Alternative Fuels**, Applied Energy Technology Series, CRC Press
- Sunggyu Lee, James G. Speight, Sudarshan K. Loyalka, **Handbook of Alternative Fuel Technologies**, CRC Press
- G.N. Tiwari, M.K. Ghosal, **Fundamentals of Renewable Energy Sources**, Alpha Science Intnl. Ltd., 2007
- H S Mukunda, **Understanding Clean Energy and Fuels from Biomass**, Wiley India
- Sobh Nath Singh, **Non-Conventional Energy Resources**, Pearson Education
- Nijaguna, B.T., **Biogas Technology**, New Age International publishers (P) Ltd.
- J W Twidell & A D Weir, *Renewable Energy Resources*, ELBS, 2006
- Tiwari GN. Ghoshal MK. *Fundamental of Renewable Energy Sources*, Narosa, 2007.

Elective (DSE)	SENVE401	Environmental Geosciences

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVE401	Environmental Geosciences	03	--	03	--	04

Course Structure: ***Elective (DSE)*** - *Teaching Scheme*

Elective: SENVE **40**1 - ***Assessment Scheme***

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVE 401	Environmental Geosciences	15	15	15	60	--	--	75

SENVE 401: Environmental Geosciences (*Elective 1) Curriculum Details*

Course pre-requisite:

This course may opt by M.Sc. students from Environmental Science subject to understand the geochemical process in the earth formation. Also, it helps to develop mapping skills and use such (topographic and geologic) maps to estimate distances, visualize landforms, and locate / identify geologic features

Course objectives:

- To develop the basic observational skills needed to function as geoscientists.
- To make quantitative measurements of various physical and chemical properties of the Earth system.
- To develop mapping skills and use such (topographic and geologic) maps to estimate distances, visualize landforms, and locate / identify geologic features.
- To identify the common forms of igneous, metamorphic, and sedimentary rock in hand samples and in field exposures using observations of mineral composition and texture.
- To teach them the Climates of India, weathering process and formation of Soil.
- The students would be able to understand the spectrum of interactions between people and the physical environment.

Course outcomes:

- Demonstrate knowledge of: physical and chemical properties of the lithosphere and
- hydrosphere (minerals, rocks, soils, and water); geologic time and earth history; and crustal materials.
- Demonstrate competence in fundamental geological skills including: mineral, rock and soil identification; interpretation of topographic maps, geologic maps, and collection of organized field and laboratory data.
- Apply the Geoscience knowledge in solving various environmental problems and issues
- Gain an understanding of the societal relevance of earth systems.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		Origin of Earth.	**15**
	1.1	Origin of Earth. Primary geochemical differentiation and formation of core, mantle, crust, atmosphere and hydrosphere.	
	1.2	Geological time scale, igneous, sedimentary and metamorphic processes; deformations	
	1.3	Concept of minerals and rocks. Controls on formation of landforms - tectonic including plate tectonic and climatic.	
	1.4	Energy budget of the Earth. Earth's thermal environment and seasons. Climates of India, western disturbances, Indian monsoon, droughts, El Nino, La Nina. Concept of residence time and rates of natural cycles Paleoclimates.	
2.0		**Internal and surficial geosystems**	**10**
	2.1	Volcanoes, earthquakes, weathering, erosion, and mass wasting; stream transport, winds and deserts	
	2.2	Weathering- Physical and Chemical Weathering processes. Soil forming minerals and process of soil formation, Identification and characterization of clay minerals, Soil physical and chemical properties,	
	2.3	soil types and climate control on soil formation, Cation exchange capacity and mineralogical controls.	
3.0		Hydrosphere and biosphere	**10**
	3.1	hydrosphere and biosphere. Partitioning of elements during surficial geologic processes; Geochemical recycling of elements.	
	3.2	Geochemical classification of elements, abundance of elements in bulk earth; crust,	
4.0		**Natural resource exploration**	
	4.1	Natural resource exploration and exploitation and related environmental concerns. Historical perspective and conservation of non-renewable resources.	**10**
	4.2	Distribution of water in earth, hydrology and hydrogeology, major basins and groundwater provinces of India, Darcy's law and its validity, groundwater fluctuations, hydraulic conductivity,	

	4.3	effects of excessive use of groundwater, groundwater quality. Pollution of groundwater resources, Geological case studies and current issues.	
		Total	**45**

Text Books:

1. Keller, E.A. Introduction to Environmental Geology. 4th ed. Prentice Hall of India. 2007.
2. Eby, N. Principles of Environmental Geochemistry. Brooks Cole, USA. 2003.
2. Bennett, M.R. and Doyle, P. Environmental geology: - Geology and the Human Environment. John Wiley and Sons.1997.
3. Botkin, Daniel B. and Keller, Edward A. Environmental Science: Earth as a Living Planet. 6th ed. John Wiley & Sons, USA. 2007.
4. Grotzinger J., Jordan Thomas H., Press Frank, Siever Raymond: Understanding Earth; Freeman and Company. 2014.
5. G.B. Mahapatra "Textbook of Geology Paperback"
6. Charless Lyell, "Principles of Geology".
7. Henry D. Foth, "Fundamentals of Soil Science".
8. V. S. Joji, "An Introduction to Geology: With Multiple Choice Questions Paperback ".
9. Lucy Wood, "Weathering Hardcover".

Reference Books:

1. Frederick K. Lutgens, Dennis G. Tasa "Essentials of Geology".
2. Stephen Marshak, "Essentials of Geology Loose Leaf".

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVE403	Current Environmental Issues	03	--	03	--	04

Elective (DSE)	SENVE403	Current Environmental Issues

Course Structure: ***Elective 2 (DSE)*** - *Teaching Scheme*

Elective: SENVE 403 - ***Assessment Scheme***

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVE 403	Current Environmental Issues	15	15	15	60	--	--	75

SENVE403: ***Title (Elective 2) Curriculum Details***
Current Environmental Issues (3 Credits)

Course pre-requisite:

1 This course may be taken up by students from any discipline to understand the fundamental concepts related to the environmental issues and the science behind them.

Course objectives:

- To understand the concept, need, scope and objectives of Environment Education.
- Sensitize the Global Environmental problems and explain the different policies related to Environmental education.
- To make students aware with present issues obstructing the sustainable environmental development.
- To Explain the teaching learning strategies and Evaluation techniques in Environment education.
- To develop new methodologies to tackle environmental problems.
- To encourage students to develop and promote awareness among the society regarding current environmental issues and related information with development of common solutions to the environmental issues.
- To undertake the role of individual/volunteer in managing these issues and to develop an awareness about environmental issues.

Course outcomes:

After successful completion of this course, a student should know

- It will help students to understand burning current environmental problems like epidemic issues, problems associated with various pollutions like Greenhouse effect, global warming, ozone depletion, solid waste and its management etc.
- Students will learn about the basic environmental issues caused by anthropogenic and natural activities and their impact as well as they will understand preventive and corrective measures to deal with.
- It may recognize potential environmental impacts of associated problems.
- Students can think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability.

Curriculum Details: ***(There shall be FOUR Modules in each course)***

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		Concept of Environmental Education:	**12**
	1.1	Meaning, need and scope of environmental education.	
	1.2	Stock Holm conference, Tbilisi conference and Earth Summit.	
	1.3	Objectives of environmental education.	
	1.4	Evolution and development of environmental education.	
2.0		Environmental Education and Awareness,	**12**
	2.1	Environmental Education and Awareness,	
	2.2	epidemiological issues, environmental amendments	
	2.3	Environmental issues related to natural resources, their management and conservation and recent happenings at national and international level, etc.	
	2.4	Recent developments in the subject	
3.0		Environmental problems and policies:	**12**
	3.1	Global warming, Kyoto Protocol, climate change	
	3.2	Policies related with environmental problems,	
	3.3	Sustainable development Environmental legislation in India.	
	3.4	Concept of healthy environment Eco club: Meaning, Characteristics & Importance.	
4.0		Recent updates on Global Environmental Issues	**09**
	4.1	green energy	
	4.2	environmental amendments	
	4.3	E-waste	
	4.4	Role of Media in Environment education	
		Total	**45**

Text Book:

- Erach Barucha (2004) Text book of Environmental Studies for Undergraduate courses (Prepared for University Grants Commission) Universities Press.
- Purnima Samarth (2018) Environmental studies Kalyani Publishers, Ludhiana

Reference books:

- Odum, E.P., Odum, H.T. & Andrews, J. (1971) Fundamentals of Ecology. Philadelphia: Saunders.
- Pepper, I.L., Gerba, C.P. &Brusseau, M.L. (2011). Environmental and Pollution Science. Academic Press.
- Raven, P.H., Hassenzahl, D.M. & Berg, L.R. (2012) Environment. 8th edition. John Wiley & Sons.
- Singh, J.S., Singh, S.P. and Gupta, S.R. (2014) Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
- Sengupta, R. (2003) Ecology and economics: An approach to sustainable development. OUP.
- Wilson, E. O. (2006) The Creation: An appeal to save life on earth. New York: Norton.
- Groom, Martha J., Gary K. Meffe and Carl Ronald Carroll (2006) Principles of Conservation Biology. Sunderland: Sinauer Associates,

SENVP401

PRACTICALS (Practical Based on 401)

ECOLOGY AND EVOLUTION

1. To study the Physical properties of soil
2. To study the Chemical properties of soil
3. To study the Biotic components of a pond
4. Measurement of Light through Lux meter
5. Determination of Dissolved oxygen in water
6. To determine the primary Productivity by Light and Dark bottle technique
7. Identification of living plankton
8. To study the community by quadrate method by determining frequency and frequency class of different species present in the community
9. To study the community by quadrate method by determining density of different species present in the community
10. To study the community by quadrate method by determining abundance of different species present in the community
11. Field trip

SENVP402

PRACTICALS (Practical Based on 402)

Air and Water Pollution

Curriculum Details: Practical list

1) Determination of pH.
2) Determination of EC.
3) To determine the Water hardness.
4) To determine the TDS content.
5) To prepare the wind rose diagram (Simple, compound).
6) Principals and working of UV Spectrophotometer.
7) Principals and working of Flame photometer
8) Principals and working of High-Volume Air Sampler
9) To estimate the Chloride content of water.
10) To determine sulphate/Phosphate/Nitrate content of water.

SENVP403

PRACTICALS (Practical Based on 403)

Energy Resource Management

1. Estimation of power requirements of a house/institute.
2. Familiarization with renewable energy gadgets
3. To study biogas plants
4. To study the production process of biodiesel
5. To study the production process of bio-fuels
6. Familiarization with different solar energy gadgets
7. To study solar photovoltaic system
8. To study about solar lighting
9. To study about solar pumping
10. To study solar cooker
11. To study solar drying system
12. To study solar distillation
13. Estimation of Coal moisture
14. To study types of Coal

SENVE 402
PRACTICALS (Practical Based on SENVE 402)
Environmental Geosciences

1) Identification of minerals in hand specimens.

2) Identification of rocks in hand specimens.

3) Identification of minerals in thin sections.

4) Identification of rocks in thin sections.

5) Field visit to geological formation.

SENVE 404

PRACTICALS (Practical Based on SENVE 404)

Current Environmental Issues

(The practical's for paper Current Environmental Issues will be based on Events / Disasters / Situations / Current Environmental Conditions etc.)

SEMESTER II

SENVC 451	**Environmental Chemistry and Toxicology**

Course Code	**Course Name (Paper Title)**	**Teaching Scheme (Hrs.)**		**Credits Assigned**		
		Theory	**Practical**	**Theory**	**Practical**	**Total**
SENVC451	**Environmental Chemistry and Toxicology**	04	--	04	--	04

SENVC 451: *Title (Major 1) Curriculum Details*

Course Structure: ***Major 1 - Teaching Scheme***

Major 1 - Assessment Scheme

Course Code (2)	**Course Name (3)**	**Theory**				**Practical**		**Total [Col (6+7) / Col (8+9)] (10)**
		CA			**ESA (7)**			
		Test I (4)	**Test II (5)**	**Avg of (T1+T2)/2 (6)**		**CA (8)**	**ESA (9)**	
SENVC 451	**Environmental Chemistry and Toxicology**	20	20	20	80	--	--	100

SENVC451: Environmental Chemistry and Toxicology *(Major 1) Curriculum Details*

Course pre-requisite:

1. This course may be taken up by students from any discipline to understand the basics of environmental chemistry and fate of chemicals. Students will learn about the basic environmental issues caused by innumerous chemicals spread by anthropogenic activities and their impact as well as they will understand preventive and corrective measures to deal with these chemicals.
2. Knowledge about chemicals, environmental health and factors affecting it.

Course objectives:

- To enhance the knowledge about fundamental chemical processes and their impact on the surroundings.
- To develop new methodologies to tackle environmental pollutions.
- To encourage students to develop and promote awareness among the society regarding pollution and its prevention.
- To undertake the role of individual/volunteer in pollution prevention.
- To understand chemical laboratory safety guidelines.
- This course aims to enable the students to gain in depth knowledge about the basics and uses of toxicology in environmental science. This basic knowledge is useful for better understanding of Environmental health.

Course outcomes:

After successful completion of this course, a student should know

- Understand about basics of Environmental Chemistry and chemicals associated risk to the surround environment.
- It will help students to understand burning current environmental issues like Air pollution, Greenhouse effect, global warming, ozone depletion etc.
- It may recognize potential environmental impacts of substances.
- They will understand chemical laboratory safety guidelines.
- It will add to their knowledge about quantitative concepts, like normality, molarity, concentration, exposure levels and limits, as it is necessary for the evaluation of the impact of a substance.
- Students are able to think critically and contribute to research in solving contemporary environmental problems with professional and ethical accountability.
- This course is useful in understanding about basics of Toxicology. This will be useful for Toxicological interpretations by environmentalists. On successful completion of the course, students should be capable of identifying different kinds of toxic substances and their metabolism and effects on environmental components.

SENVC451 *Environmental Chemistry and Toxicology (4 Credits)*

Curriculum Details: (*There shall be FOUR Modules in each course)*

ModuleNo.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		Basics of Environmental Chemistry	**10**
	1.1	Introduction, Concept and scope, Importance	
	1.2	Alkalinity / Acidity of water, Concept and types of dilution, Single step dilution, Serial dilution, Multiple step dilution,	
	1.3	Sample collection guidelines, Sample preservation, Sampling order, Sample labeling, Data collection and record keeping, Laboratory safety procedures. Accuracy and Precision,	
	1.4	Use of chemicals in potable water treatment, Potable water quality standards, Hydrocarbons, saturated and unsaturated hydrocarbons, Buffer solutions and their role, Soaps, Detergent wastes and its effects, Paints.	
2.0		Industrial activity and environment,	**20**
	2.1	Industrial activity and environment: Chemistry of Air pollutants from industries, particulate matter, Photochemical Smog formation,	
	2.2	Chemistry of acid rain, Formation of acid rain, Effects of acid rain, Efforts to control acid rain,	
	2.3	Global warming: Effects and Control measures	
	2.4	Bhopal gas tragedy, Carcinogens, Carbon sequestration, Ozone depletion, Trace metal characteristics in relation to toxicity, Biochemical effects of trace elements.	
3.0		**Hazardous Waste and Toxicity**	**20**
	3.1	Introduction and scope, Toxic substances, Basic principles of toxicology,	
	3.2	Damage Process and Action of Toxicants, Factors Affecting Xenobiotic Action, Metabolism of Environmental Chemicals, Defense Responses to Toxicants, Evaluation of toxicity	
	3.3	Metal toxicity- Metals in bio-sorption- Air, Water, Soil, Plants, Animals, Microorganisms, Arsenic, Cadmium, Chromium, Copper, Iron, Lead, Mercury.	
	3.4	Pesticide toxicity, Organo-chlorines, DDT, Carbamates, Organo-phosphates, Chlorinated phenoxy substances	
4.0		**Mutagenic Pollutants & Environmental Cancer**	**10**
	4.1	Types of Mutation, Effect of Mutations,	
	4.2	Causes of Cancer, Stages in the Development of	

		Cancer, Metastasis,	
	4.3	Classification of Carcinogens,	
	4.4	Metabolism of Chemical Carcinogens	
		Total	**60**

References:

Text Books:

- Environmental Chemistry: B.K. Sharma, and H. Kaur, Goel Publishing House.
- Environmental Chemistry by A K. De, New Age International Publishers
- Elements of Environmental Chemistry: H.V. Jadhav.
- Environmental Chemistry: Samir K. Banerjee, Prentice Hall of India Pvt. Ltd. New Delhi.
- Environmental Chemistry: J. W. Moore and E. A. Moore
- Environmental Pollution, N. Manivasakam
- A Test Book of Environmental Chemistry & Pollution Control by S. S. Dara, S. Chand and Co.
- Fundamentals of Environmental Chemistry by Manahan, Stanley E.
- Chemistry of the Environment by Sonja Krause, Herbert M. Clark, James P. Ferris, Robert L. Strong, Elsevier Science & Technology Books

Reference Books:

- Applications of Environmental Chemistry by Eugene R. Weiner, CRC Press, LLC
- Environmental Pollution Analysis: Khopkar
- Environmental and Man: The Chemical Environmental: J. Lenihan and W.W. Fletcher
- **Water Toxicology:** V. V. Metelev, A. I. Kanaev, N. G. Dzasokhova, Amerind Publishing Company, Pvt, Ltd, New Delhi (1971).
- **Water Pollution and Toxicology:** S. K. Shukla & P. R. Srivastava, Commonwealth Publisher, New Delhi (1992).
- **Toxicology – Principles & Methods:** M. A. Subramanian, MJP, Publishers, Chennai (2004).
- **Environmental Pollution Health & Toxicology:** S V S Rana, Narosa Publishing House, New Delhi (2006).
- **Toxicology:** P D Sharma, Rastogi & Company, Meerut (1995).
- **Principles of Environmental Toxicology:** Ian Shaw & John Chadwick, Taylor & Francis, Padstow UK (1998).
- **Industrial & Hazardous Wastes (Health Impacts & Management Plans):** R K Sinha & Sunil Herat, Pointer Publisher, Jaipur (2004).
- **Environmental Pollution: Radiation:** D Prasad & M L Choudhary, Venus Publishing House, New Delhi (1992).
- **A textbook of Environmental Chemistry & Pollution Control:** S S Dara, S Chand & Company Ltd, New Delhi (2002).

Course Structure: *Major 2 - Teaching Scheme*

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVC 452	Environmental Analytical Techniques	04	--	04	--	04

Major 2 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVC 452	Environmental Analytical Techniques	20	20	20	80	--	--	100

SDSCC101: Environmental Analytical Techniques *(Major 2)*
Curriculum Details

Course pre-requisite:

1. This course may opt by M.Sc. students from Environmental Science subject to understand the analytical techniques for air, soil and water contaminants.

Course objectives:

- The aim of this paper is to provide skills and an improved understanding of analysis of environmental contaminants.
- To study and analyse the impacts of air, soil and water contaminants (energy, resources/waste) within the built, urban, agricultural and natural environments.

Course outcomes:

- Analyse and interpret the air, water, soil etc pollution problems.
- Students can be able to handle the various instrument and their applications in analysis of soil, water and air contaminants.
- Students are able to think critically and contribute to research in solving contemporary air and water pollution problems with professional and ethical accountability.

Curriculum Details:

Module No.	UnitNo.	Topic	Hrs. Required to cover the contents
1. 0		**Introduction**	**15**
	1.1	Significance and the role of Instruments in various analysis, Factors affecting measurement etc.	
	1.2	Classification of Instrumental methods, Types of errors: Determine errors, Indeterminate errors,	
	1.3	Principals of colorimetry, theory, working and applications.	
	1.4	Fluoride meter principle, working, etc.	
2.0		**Air quality assessment**	**10**
	2.1	High Volume Air Sampler, Respirable Dust Sampler uses,	
	2.2	Hand-held high-volume sampler	
	2.3	Air quality instruments and operation, principals and working	
3.0		**Digital and portable instruments**	**15**
	3.1	Digital pH meter, Temperature, GPS, Conductivity meter and its working,	
	3.2	Nephelometry and Turbidity meter **a**pplications in Environmental studies, potentiometry method,	
	3.3	types of electrodes	
4.0		**Water quality measurements**	**20**
	4.1	Principle and working of ICPAES, Principle and working of Spectrophotometer, Ultra Violet (UV), Spectrophotometer working and applications, Infrared (IR) Spectrophotometer: working and applications,	
	4.2	Atomic Absorption Spectrophotometer (AAS): working, applications and its importance, Flame Photometer: working and applications in environmental Analysis, Uses and working of BOD cooling incubator, Laminar air flow applications and working,	
	4.3	Colony counter its working and applications in microbial	

		study, COD digester working and uses for analysis of various effluents and samples, Gas analyzer applications and working, Industrial stack analyzers, Chlorine testing kit applications, Soil testing kit and its importance in nutrient study.	
		Total	**60**

Text Books:

- Gurdeep Chatwal, "Instrumental Methods of Chemical Analysis": (Himalaya Publishing House, New Delhi), 2000
- Willard Merit and Dean "Instrumental Methods of Analysis": (CBS Publication, New Delhi
- Karan Sareen "Instrumental Methods of Environmental Analysis" (Sarup & Sons Publishers, New Delhi), 2001
- B. K. Sharma, "Instrumental Methods of Chemical Analysis": Goel Publishing House, Meerut (1996).
- H. Kaur, Pragati Prakashan, Merrut "Instrumental Methods and chemical Analysis: (2009).
- V. B. Borade, "Instrumental Methods**:** (Nirali Prakashan, Mumbai)

Reference Books:

- Standard Methods for the Examination of Water and Waste Water: (APHA, AWWA & WPCF), 1985.
- Shoog Holler, "Instrumental Analysis": (Harcourt Asia Publishers Ltd., New Delhi), 1952
- Chatwal and Anand, "Instrumental Methods of chemical Analysis: (Himalaya Publishing House, New Delhi), 1994
- W. Ferren, "Instrumental Analysis for science and technology": (Agrobios India, Jodhpur)

Course Structure: *Major 3 - Teaching Scheme*

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVCC453	Environmental Microbiology	04	--	04	--	04

Major 3 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVCC453	Environmental Microbiology	20	20	20	80	--	--	100

SENVCC453: Environmental Microbiology
(Major 3) Curriculum Details

Course pre-requisite:

1. Student must have Knowledge about Basic Biology
2. Student must understand microbes, their presence and their use in daily life

Course objectives: This course will enable student to

- Understand different kinds of microbes in environment
- Gain knowledge about microbial and cell biology
- Understands metabolism of microbes and their growth
- Role of microbes in health and environmental problems

Course outcomes:

After learning the course, the students should be able to:
1. Use the working knowledge of microbiology to appreciate the role of microbes in environmental pollution problem survey.
2. Relate the role of microorganisms in spread of human diseases and control.
3. Select the type of physical and chemical agents for microbial control for further studies.
4. Justify the role of microbes in bioremediation and industrial use for healthy ecosystem

Curriculum Details: *(There shall be FOUR Modules in each course)*

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		**Types of Microbes and their interactions**	**10**
	1.1	Prokaryotic and Eukaryotic Microorganisms;	
	1.2	Characteristics of diverse groups of microorganisms;	
	1.3	Classification of microorganisms; Microbial diversity;	
	1.4	Plant-microbe and soil-microbe interactions;	
2.0		Cell Chemistry and Cell Biology	**10**
	2.1	Structure of proteins, nucleic acid (DNA & RNA), lipids and polysaccharides; Bonds in biomolecules;	
	2.2	Stereoisomerism in biomolecules; Structure of cell; Structure and function of cytoplasmic membrane, cell wall, outer membrane, glycocalyx,	
	2.3	chromosomes, endospores, storage products, mitochondria and chloroplasts.	
3.0		Microbial Metabolism	**20**
	3.1	Anabolism and catabolism; Phosphorylation; Glycolysis; TCA cycle; Electron transport chain; Fermentation; Anaerobic respiration; Energy balances; Enzymes and Enzyme kinetics.	
	3.2	Growth and Control of Microorganisms: Bacterial nutrition and growth; Specific growth rate and doubling time; Monod's model;	
	3.3	Types of culture media; Batch and continuous culture; Effects of environmental factors on growth; Control of microbes using physical and chemical methods.	
4.0		Health and Environment	**20**
	4.1	Microbial diseases and host-pathogen interactions; Antibiotics and antimicrobial resistance. Pathogens and modes of transmission; Indicator organisms;	

	4.2	Quantification of coliforms using MPN and membrane filtration techniques.	
	4.3	Role of microorganisms in wastewater treatment, bioremediation and biogeochemical cycling.	
	4.4	Application of microbes in environmental conservation, Investigations in environmental microbiology: sampling, detection, isolation, Bioremediation microbial awareness and sanitation education.	
		Total	**60**

Text Books:

1. P. D. Sharma, Microbiology, (Rastogi publication Meerut)
2. Pelczer, Reid & Chan, Microbiology, (Tata McGraw-Hill Publishing Company Limited, New Delhi)
3. M. C. Kinnery, Microbiology for Environmental Engineering, (Tata McGraw-Hill Publishing Company New Delhi)
4. Kale & Kishore Bhusari, Microbiology, (Himalaya Publishing House, Mumbai)

Reference Books:

1. C. B. Powar & H. F. Daginawala, General microbiology Volume I & II, (Himalaya publishing House, Mumbai), 2002
2. A. J. Salle, Fundamental principles of Bacteriology, (Tata McGraw-Hill Publishing Company, New Delhi), 1974
3. Yu. S. Krivashein, Hand book of Microbiology, (Mir Publishers Moscow)

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVE451	Environmental Economics	03	--	03	--	03

Course Structure: *Elective 1 - Teaching Scheme*

Elective 1 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVE451	Environmental Economics	15	15	15	60	--	--	75

SENVE451: Environmental Economics *(Elective 1)*

Course pre-requisite:

1. Student must have basic knowledge about Environmental Resources
2. Student must have awareness about Environmental problems

Course Objectives:

1. This course aims to enable the students to gain knowledge about importance of Natural resources in the economy
2. This course aims to enable the students to know about how the Natural resources and the economy are related to each other
3. This course aims to enable the students to gain knowledge about how the Natural resources drive the economy

Course outcomes:

On successful completion of the module, students should be capable of

1. Understanding Economy of Natural resources
2. Understanding importance of natural resources
3. Analyze the markets, externalities, cost and benefits
4. Identifying the benefits to achieve sustainable development

Curriculum Details

Curriculum Details: *(There shall be FOUR Modules in each course)*

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		The concept of resources and resource scarcity	**15**
	1.1	an economic perspective: Resource scarcity,	
	1.2	economic efficiency and markets	
	1.3	Market signals of natural resource scarcity: resource price, rent and extraction cost	

	1.4	The market, externality, and the ªoptimalº trade-off between environmental quality and economic goods	
2.0		Biophysical limits to economic growth	**10**
	2.1	the Malthusian perspective the neoclassical economic perspective the ecological economics perspective	
	2.2	The economics of sustainable development	
	2.3	The economic theory of pollution control: the optimal level of pollution	
3.0		The economics of environmental regulations	**10**
	3.1	regulating the environment, through judicial procedures,	
	3.2	regulating the environment, through pollution tax	
	3.3	regulating the environment, through markets for pollution permits	
4.0		The economic theory and measurement of environmental damage (benefit)	10
	4.1	The economics of atmospheric pollution	
	4.2	valuing the environment framework for assessing the worthiness of an environmental project: cost benefit analysis	
	4.3	Population, development and environmental degradation in the developing	
		Total	**45**

Text Books:

- Peter Berck, Economics of the Environment, Pearson Education India
- Shubhashini Muthukrishnan, Economics of Environment, PHI Learning Pvt. Ltd.
- Bhattacharya Rabindranath, Environmental Economics: An Indian Perspective, Oxford university press

Reference Books:

1. Ahmed M. Hussen, Principles of Environmental Economics, Routledge, 11 New Fetter Lane, London EC4P 4EE
2. Charles D Kolstad, Environmental Economics, Oxford university press
3. Steven C Hackett, Environmental and Natural Resources Economics, Routledge, 11 New Fetter Lane, London EC4P 4EE.
4. Roger Perman and others, Natural Resources and Environmental Economics, Addison Wesley

Course Code	Course Name (Paper Title)	Teaching Scheme (Hrs.)		Credits Assigned		
		Theory	Practical	Theory	Practical	Total
SENVE453	Biodiversity and Wildlife management	03	--	03	--	03

Course Structure: *Elective 2 - Teaching Scheme*

Elective 2 - Assessment Scheme

Course Code (2)	Course Name (3)	Theory				Practical		Total [Col (6+7) / Col (8+9)] (10)
		CA			ESA (7)			
		Test I (4)	Test II (5)	Avg of (T1+T2)/2 (6)		CA (8)	ESA (9)	
SENVE453	Biodiversity and Wildlife management	15	15	15	60	--	--	75

SENVE453: Biodiversity and Wildlife Management *(Elective 2)*
Curriculum Details

Course pre-requisite:

3. Student must have knowledge about wildlife
4. Student must have biological knowledge

Course objectives: This course aims to

- Gain knowledge about importance of Biodiversity and Wild life
- acquire knowledge about distribution different zones of Wild life
- understands methods of conservation of Biodiversity and Wild life

Course outcomes: After completion of this course, Student can

- identify different habitats, zoogeographical zones and regions in India.
- understands importance of biodiversity and know measurement methods of biodiversity of the region
- gain knowledge about different wildlife management and conservation methods

Curriculum Details: *(There shall be FOUR Modules in each course)*

Module No.	Unit No.	Topic	Hrs. Required to cover the contents
1. 0		Biodiversity and Conservation	**10**
	1.1	Biodiversity and Conservation: Importance of conserving biodiversity;	
	1.2	ecosystem services; Threats to biodiversity; invasive species;	
	1.3	in-situ conservation (endemism, biodiversity hotspots, protected areas); ex-situ conservation;	
	1.4	conservation genetics (genetic diversity, inbreeding depression); DNA fingerprinting and DNA barcoding	

2.0		Wildlife and zoogeographical regions of the world	**10**
	2.1	Wild flora and fauna, macro and micro flora and fauna, wild habitats and wilderness, zoogeography of the world, zoogeographical regions.	
	2.2	Wildlife and zoogeography of India and the Indian Sub-continent Wild flora and fauna of India.	
	2.3	Zoogeography of India. The convergence of zoogeographical regions in the Indian Subcontinent. Our neighboring zoogeographical regions.	
3.0		Introduction to wildlife management.	**15**
	3.1	Laws, Acts and rules for wildlife conservation and management. Protected Areas of India. National Parks and Wild Life Sanctuaries. Community Conservation Areas. Biodiversity Registers. The Indian Forest Service. State Forest Services.	
	3.2	Major wildlife habitats and conservation areas in India, The major conservation zones for wildlife in India –	
	3.3	Major National Parks and Wildlife Sanctuaries in India	
4.0		Conservation breeding and zoo management	**10**
	4.1	Captive breeding, in situ vs ex situ conservation,	
	4.2	Major zoological parks of India, the Central Zoo Authority	
	4.3	Role of modern genetics and biosciences in captive breeding of endangered species.	
		Total	**45**

Text Books:

1. SK Singh, Textbook of Wildlife management. CBS Publisher
2. Reena Mathur, Wildlife Conservation and Management, Rastogi Publication
3. Gautam Kumar Saha, Wildlife biology: An Indian Perspective, PHI Publications
4. Aldo Leopold, Wildlife Conservation and Management, Rastogi Publication, Natraj Publishers.

Reference Books:

1. Rajesh Gopal, Fundamentals of Wildlife management, Natraj Publishers
2. P R Krausman & J W Cain III, Wildlife Management and Conservation, Johns Hopkins University Press

SENVP 451

PRACTICALS (Practical Based on SENVP451)

Environmental Chemistry and Toxicology

1. Introduction to Laboratory Glassware and Supplies
2. Safety in the Environmental Chemistry Lab
3. To study MSDS
4. To study first aid in Chemical Lab
5. How to store Chemicals in Lab
6. To determine normality and molarity of a solution
7. Preparation of solutions
8. Preparation of Buffer solution, Calibration of Instrument
9. To determine the pH value of the given samples of Water/ effluent sample
10. To determine the pH value of the given samples of Soil sample
11. To determine the total / Suspended solids of a given sample of water
12. To determine the alkalinity of a given water sample
13. To determine the acidity of a given water sample
14. To determine the hardness of the given water samples
15. Study of instruments and equipment used in the Toxicological study.
16. Isolation and Enumeration of microorganisms from soil
17. To determine the Effect of Heavy Metal toxicants
18. To determine the Effect of effluents containing heavy metals on seed germination
19. Determination of LC50
20. Determination of LD50
21. To study Effect of different concentrations of heavy metals on growth

SENVP 452

PRACTICALS (Practical Based on SENVP 452)

Environmental Analytical Techniques

1) To study the principal and working of High-Volume Air Sampler.

2) To study the principal and working of UV Spectrophotometer.

3) To study the principal and working of Flame photometer.

4) To estimate the DO of given samples.

5) To estimate the COD of given samples.

6) To study the different types of analytical errors.

7) To Prepare the buffer solutions of different standards.

8) To visit the industrial ETP/STP plant and know the principal and working of plant.

9) To study the different nutrients from effluent/given samples.

10) To visit the STP plant and know the principal and working of plant.

SENVP 453

PRACTICALS (Practical Based on SENVP 453)

ENVIRONMENTAL MICROBIOLOGY

1. Microscopy and staining: Microscope, Types, Magnification, Resolution, Use of oil immersion objective
2. Compound microscope: Principle, Working and significance
3. Concept and types of stains, Smear Preparation, Simple and Differential staining Grams and Acid-fast staining
4. Classification of bacteria based on: Nutrition, Physical factors: pH, Temperature, Water activity, Aeration
5. Chemical factors: Media, types of media, media ingredients
6. Methods in Microbial culture: Pure culture technique, Streak plate, Pour plate, spread plate
7. Sterilization methods: Sterilization by Physical agents, Dry heat and moist heat, Radiation etc.
8. Chemical Sterilization: Ethylene oxide, Formaldehyde, Sterilization by filtration membrane filter
9. Control of microbes, Pasteurization, Ultraviolet light
10. Bacteriological examination of potable water MPN

SENVE 452

PRACTICALS (Practical Based on SENVE 452)

ENVIRONMENTAL ECONOMICS

PRACTICALS BASED ON FOLLOWING CASESTUDIES

1. Economic returns from the biosphere
2. Ranching for subsidies in Brazil
3. The economic impact: the 1990 Clean Air Act amendments
4. Asset recycling at Xerox
5. Sustainable forest management practice: the case of the Menominee Indian Reservation
6. Habitat preservation of endangered fish species in the Virgin River systems: an application of the safe minimum standard approach
7. Economic effects of poor indoor air quality
8. Purchasing pollution
9. Economics and the Endangered Species Act
10. Economics and the Endangered Species Act: costs of species protection
11. The roots of overfishing
12. Overreacting to overcapacity
13. Mining the earth
14. Communal tenure in Papua New Guinea

SENVE 455

PRACTICALS (Practical Based on SENVE 455)

Biodiversity and Wildlife management

1. Assessment of biodiversity in and around water bodies

2. Assessment of biodiversity of terrestrial area

3. The various sciences in wildlife studies: Mammalogy, Ornithology, Ichthyology, Herpetology, Entomology, Population ecology, Animal ethology, Phenology.

4. Wildlife management: Protected Areas of India. National Parks and Wild Life Sanctuaries. Community Conservation Areas.

5. Major wildlife habitats and conservation areas in India: The major conservation zones for wildlife in India – the Himalayas, the North-East, the West and East Coast, the Islands in the Indian Ocean, the deserts and

6. semi-arid regions, the Western Ghats and the Eastern Ghats, the Satpuras and the Vindhyas, the Rivers of India.

7. Major National Parks and Wildlife Sanctuaries in India: Corbett, Kanha, Bandavgarh, Tadoba, Nawegaon-Nagzira, Mudumalai, Bandipur, Namdapha, Keoladeo Ghana, Mundanthurai, Point Calimere, Periyar and the Chambal among others.

8. Field trip