AC/26/04/25/RS1

SIES College of Arts, Science & Commerce (Empowered Autonomous)

RISE WITH EDUCATION

SIES College of Arts, Science and Commerce
(Empowered Autonomous)
Affiliated to University of Mumbai

Syllabus under NEP effective from June 2025

Programme: B.Sc.
Subject: Environmental Science
Core Course
Class: TYBSc
Choice Based Credit System (CBCS)

Semester V

Core Course\Vocational Skill Enhancement Course\ Skill Enhancement Course\Open Elective\AEC\IKS\VEC

Name of Program: B.Sc.			**Name of Department:** Environmental Science			
Class	**Semester**	**Course Type**	**Course Name**	**Course Code**	**No. of lectures/ per week**	**Credits**
TYBSc	V	Major DSC - I	Environmental Policies and Regulations	SIUESMJ311 (T); SIUESMJP311 (P)	3T + 1P	4
TYBSc	V	Major DSC - II	Climate Change & Sustainable Development	SIUESMJ312 (T); SIUESMJP312 (P)	3T + 1P	4
TYBSc	V	Major DSC - III	Natural Resources Management	SIUESMJ313 (T); SIUESMJP313 (P)	3T + 1P	4
TYBSc	V	Major DSE - II	Occupational Health and Safety	SIUESEL312 (T); SIUESELP312 (P)	3T + 1P	4
TYBSc	V	Minor	Environmental Chemistry	SIUESMN311	2T	2
TYBSc	V	VSC	Research Methodology	SIUESVS311	2T	2
TYBSc	V	FP	–	SIUESFP311	–	2

<table>
<tr><td colspan="3">Course Name: Major DSC 1: Environmental Policies and Regulations
Credits: 3 Type: Core</td></tr>
<tr><td colspan="3">Course Outcomes
On completion of this course, students will be able to
● Understand the policy and framework for Environmental Management.
● Acquire the knowledge of the basic concept of Act, Rules and Treaties.
● Review international practices in relation with effective implementation of laws.</td></tr>
<tr><td>Unit I</td><td>Introduction to Environmental Governance</td><td>15 lectures</td></tr>
<tr><td></td><td colspan="2">● History of inclusion of the environment as a part of the Constitution; Amendments and their implementation.
● Constitutional perspective; Fundamental rights & duties and Directive principles of state policy.
● National Environmental Policy.
● Environmental Regulation Framework in India.
● Movements related to Environment: Chipko movement, Sardar Sarovar Narmada dam, Silent Valley.
● Court cases: Ganga Action Plan case, Taj Trapezium case, Oleum gas case.</td></tr>
<tr><td>Unit II</td><td>Provisions of Acts, Rules and its Amendments</td><td>15 lectures</td></tr>
<tr><td></td><td colspan="2">● Indian Forest Act, 1927.
● Indian Wildlife (Protection) Act, 1972.
● Water (Prevention and Control of Pollution) Act, 1974.
● Forest Conservation Act, 1980.
● Air (Prevention and Control of Pollution) Act, 1981.
● Environment Protection Act, 1986.
● Noise Pollution (Regulation and Control) Rules, 2000.
● Biodiversity Act, 2002.
● Municipal Solid Waste (Management and Handling) Rules, 2000.</td></tr>
</table>

	• The Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008. • National Green Tribunal Act, 2010. • Coastal Regulation Zone (CRZ) Rules, 2011. • The Plastic Waste Management Rules, 2016. • E-waste (Management) Rules, 2016.	
Unit III	**International Conventions and Treaties**	**15 lectures**
	• Ramsar Convention 1971. • Stockholm Conference 1972. • Vienna Convention 1985. • Montreal Protocol 1987. • Basel Convention 1989. • Earth Summit 1992; UNFCCC- Kyoto Protocol 1997; Paris Agreement. • Convention on Desertification 1996. • Convention on Biodiversity & Cartagena Protocol on Biosafety 2003.	

Course Name: Major DSC 1 Practical (Environmental Policies & Regulations)
Credit: 1

Course Outcomes

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

- Acquire the knowledge of different clauses under the Air, Water and Noise Act.
- Build their perception on the judgement given in the cases regarding the environment.
- Interpret the judgments given as part of various environmental laws.

Practical No.	Title
1.	Study of any two legal case studies on violation of the Air Act.
2.	Study of any two legal case studies on violation of the Water Act.
3.	Study of any two legal case studies on violation of the Noise Act.

References
1. A. K Tiwari (2006). Environmental Laws in India. 2. Shastri S.C. 2008. Environmental Law, (2nd Edn), Eastern book company, Lucknow. 3. S.K. Mohanty, 2011, Environment and Pollution Law, University Law Publication Co.Pvt. Ltd. 4. Shyam Divan and Armin Rosencranz, 2005, Environmental Law and Policy in India, Oxford University Press, New Delhi.

Course Name: Major DSC 2 (Climate Change and Sustainable Development) Credits: 3 Type: Core		
Course Outcomes On completion of this course, students will be able to: ● Differentiate between climate change and global warming and understand the various human influences, internal and external forcing mechanisms affecting the climate. ● Realise the scope, importance, and opportunities for sustainability. ● Analyse and formulate future goals of sustainability.		
Unit I	**Introduction to Climate**	**15 lectures**
	● Geological time scale. ● Understanding climate. ● Role of clouds and aerosols. ● Insolation and its impact on land, Ocean and atmosphere. ● Energy balance. ● Intertropical convergence zone. (ITCZ) ● Indian monsoon pattern. ● Oceanic circulations (El Niño, La Niña). ● Atmospheric circulations. ● Latitude and climate variation.	
Unit II	**Understanding Climate Change - Introduction and Impacts**	**15 lectures**
	● Global warming.	

	• Climate change, Human influences, Internal forcing mechanisms and external forcing mechanisms. • The Milankovitch Cycle theory, Solar variation. • Impacts of Climate change on environment - Melting of glaciers, Sea level rise, Ocean acidification, Loss of biodiversity. • Impacts of Climate change on agro-industries and economy.	
Unit III	**Sustainable Development**	**15 lectures**
	• Concept of ecological footprints, carbon footprint, carrying capacity. • Origin of sustainable development, WCED. • Definition, Pillars of sustainable development. • Tragedy of Commons. • Agenda 21. • COP. • Millennium Development Goals, Sustainable Development Goals. • LiFE.	

Course Name: Major DSC 2 (Climate Change and Sustainable Development Practical)
Credit: 1

Course Outcomes

On completion of this course, students will be able to

- Accurately determine and compare the carbon sequestration potential of various tree species
- Conduct detailed ecological footprint calculations and prepare comprehensive reports
- Calculate carbon footprint for different activities, lifestyles, and processes, and develop well-structured reports.
- Design and conduct surveys to assess the economic sustainability of eco-friendly products.

Practical No.	Title
1.	Determination of carbon sequestration potential of different tree species.
2.	Calculation of ecological footprint - report preparation.

3.	Calculation of carbon footprint - report preparation.
4.	Survey on economic sustainability of eco-friendly products.

References

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Climate Change and India: Vulnerability Assessment and Adaptation by P.R Shukla, Subodh Sharma, N.H. Ravindranath , Amit Garg and Sumana Bhattacharya
3. Mainstreaming Adaptation to Climate Change in Least Developed Countries (Ldcs) by SaleemulHuq, Atiq Rahman, International Institute for Environment and Development
4. Rogers, P. P., Jalal, K. F., Boyd, J. A. (2012). An Introduction to Sustainable Development. United Kingdom: Earthscan.
5. Our Common Future, Chapter 2: Towards Sustainable Development: Report of the World Commission on Environment and Development.
6. World Resources Institute (1995) "Environmental Indicators: A Systematic Approach to Measuring & Reporting on Environmental Policy Performance in the Context of Sustainable Development", World Resources Institute, Washington, DC.
7. Environment and Sustainable Development. (2013). India: Springer India.
8. Dr. Mishra A, Dr.Dahiya V., Dr.Tandon K, JSR Publishing House LLP; (2019) Sustainable Development in the Digital Era.
9. Jeffrey D. Sachs and Ban Ki–moon, Columbia University Press (2015) The Age of Sustainable Development.
10. Kalam APJ, Singh, Penguin India (2011). Target 3 Billion: Innovative Solutions Towards Sustainable Development.

Course Name: Major DSC 3 (Natural Resources and Management)

Credits: 3 Type: Core

Course Outcomes

On completion of this course, students will be able to

- Understand the concept of natural resources.
- Explore the management practices associated with land and forest resources
- Understand water and mineral resources and its management

Unit I	**Introduction to Natural resources**	**15 lectures**
	• Definition • Classification of natural resources • Formation of natural resources • Distribution of natural resources (national and global).	

	• Importance and uses of natural resources. • Demand of natural resources due to population, lifestyle. • Need for natural resource management.	
Unit II	**Land and Forest resource management**	**15 Lectures**
	• Problems associated with land and forest resource management. • Agricultural practices in India, exploitation of agricultural land, development of waste land. • Land use changes in India (case studies), Future demands of Forest land • Forest management practices: Afforestation, Joint forest management, Agroforestry, Social forestry, Urban forestry, Protected forest area management. • Case study on forest resource management (Aarey Colony forest, Native forest revival Nilgiris, Community conservation in Assam's gethsemane)	
Unit III	**Water and Mineral resources**	**15 Lectures**
	• IKS-I: Traditional water management techniques & metallurgy. • Problems associated with water, mineral resource management and mining. • Water and Mineral resource management - concept and classification. • Management practices: Groundwater recharging, watershed development, integrated water resource management • Conservation of mineral resources of India. • Oceans as new areas for exploration of minerals. • Mineral recycling.	

Course Name: Major DSC 3 Practical (Natural Resources and Management Practical) Credit: 1
Course Outcomes On completion of this course, students will be able to • Identify different types of minerals and understand their formation. • Calculate the calorific value of different types of fuel. • Understand the vegetation pattern in India and factors affecting it. • Estimate water footprint.

- Understand energy consumption pattern and develop survey skill.

Practical No.	Title
1.	Identification of rocks and minerals on the basis of physical characters.
2.	Estimation of energy content in solid and liquid energy resources: Petrol and Diesel; Husk, Fodder and Wood
3.	Map plotting of forest types of India
4.	Calculation of water footprint at household level.
5.	Energy consumption patterns in different areas - Questionnaire method.

References

1. Michael, P. (1984). Ecological Methods for Field and Laboratory Investigations. India: Tata McGraw-Hill Publishing Company Limited.
2. Bali, S (2000) Land Resource Management in India. Souvenir of International Conference on Land Resource Management for food, employment and environmental security, 9 – 13 November 2000. Organized by Soil Conservation Society of India. Pp. 29 – 48.
3. Department of Land Resources (2000) Ministry of Rural Development, Government of India, New Delhi.
4. Agarwal, K.M., Sikdar, P.K., Deb., S.C (2005) A Textbook of Environment, Macmillan India Limited
5. Rao, M. S. (1979). Introduction to Social Forestry. India: Oxford & IBH Publishing Company.
6. Anand S. Bal. (2005). An Introduction to Environmental Management, Himalaya Publishing House.
7. Oliver S. Owen. (1980). Natural resources conservation – An Ecological approach, 3rd edition, Macmillan publishing Co. Inc. New York.
8. Agarwal and Rana S.V.S. (1985). Environment & Natural resources, society of Biosciences.
9. Sharma V.K. (1985). Water resources planning and management, Himalaya Pub. House.
10. Maheshwar Dayal. (1992). Renewable energy. Konark publishers Pvt. Ltd.

Course Name: Major DSE II (Occupational Health and Safety) Credits: 3 Type: Core
Course Outcomes On completion of this course, students will be able to ● Comprehend the principles and practices of Occupational Health and Environmental Safety Management. ● Recognize the importance and implementation of Occupational Health Management Services at the workplace. ● Familiarize with occupational health and safety rules, regulations, and the purpose and importance of policies and legislation. Implement effective safety and health management systems in accordance with OSHA guidelines, OHSAS – 18001, and Bureau of Indian Standards on safety and health.

Unit I	**Introduction to Occupational hazard**	**15 lectures**
	● Introduction to occupational health hazards. ● Introduction to physical and mental health issues. ● Hazards faced by employees in different sectors: chemical industries, waste handling, nuclear plants, transport system, IT sectors, Health care sectors, small and medium scale enterprises, law enforcement, disaster management, education and research sector.	
Unit II	**Occupational Health and Environmental Safety**	**15 lectures**
	● Role of safety department, Safety committee and function, Role and responsibilities of safety officer ● Occupational health issues in unorganised sectors and their consequences: silicosis, asbestosis, heat stress, carcinoma, orthopaedics and neurological problems from physical stress. ● HIV/AIDS, migration related health problems, Workplace gender discrimination, maternity and menstrual hygiene issues ● Concept of safety and risk. Safety and productivity. Importance and types of safety protocols in different sectors. Importance of nutritional status.	

Unit III	Occupational health and safety rules and regulations	15 lectures
	• OSHA guidelines, OHSAS – 18001. • International Labour Organisation (ILO) • ISO 45001 (OHS), Promotional Framework for Occupational Safety and Health Convention, 2006. • Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000. • Building and Construction workers Act, 1996. • Constitutional framework on health and safety of employees in India, National Policy on Safety, Health and Environment at Workplace (NPSHEW), Factories Act, 1948 (the safety aspects only).	

Course Name: Major DSE II Practical (Occupational Health and Safety Practical)
Credit: 1

Course Outcomes

On completion of this course, students will be able to

- Conduct surveys to analyze organizational waste management systems.
- Identify and differentiate between RPE and Non-RPE kits, ensuring proper use in occupational settings.
- Acquire hands-on skills in creating and using various types of rescue knots essential for emergency situations.
- Identify pictograms and safety signs related to occupational hazards, enhancing awareness and compliance with safety standards.
- Learn techniques for handling and managing trauma injuries effectively, prioritizing life-saving interventions and safety.

Practical No.	Title
1.	Conduct a survey on waste management in an organisation and prepare and SOP for safe handling, storage & disposal of the waste
2.	Identification of PPE - RPE and Non RPE.
3.	Demonstration of different types of rescue knots.
4.	Identification of pictograms related to occupational safety.

5.	Handling and managing trauma injuries.

References

1. Reese, C. D. (2018). Occupational Health and Safety Management: A Practical Approach, Third Edition. United Kingdom: CRC Press.
2. Rao, S. S. (2000). Industrial Safety, Health And Environment Management Systems. India: Khanna.
3. Jain, R. K, Rao, S. S. (2006). Industrial Safety, Health And Environment Management Systems. India: Khanna.
4. Encyclopaedia of Occupational Health and Safety. (1998). Switzerland: International Labour Office.
5. Slote, L. Handbook of Occupational Safety and Health. United States: John Wiley & Sons.

Course Name: Minor (Environmental Chemistry)

Credits: 2 Type: Core (Theory)

Course Outcomes

On completion of this course, students will be able to

- Analyze the chemical processes occurring in different components of the environment such as the atmosphere, hydrosphere, and lithosphere.
- Assess the effects of pollutants on the chemistry of the environment. Apply chemical knowledge to the analysis, treatment, and remediation of pollutants.

Unit I	**Introduction to Environmental Chemistry**	**15 lectures**
	• Chemistry of Processes in the Atmosphere- Tropospheric Chemistry, Stratospheric Chemistry, Photochemical reaction. • Chemistry of Processes in the Hydrosphere- rainwater, surface water, groundwater, sea water, brackish water, Acid-Base Reactions, Redox Reactions, Complex Formation. • Chemistry of Processes in the Lithosphere- Chemical Weathering, Dissolution and Precipitation of Solids, Dissolution of Natural Oxides, Humic Substances (HS), Decomposition of Organic Materials Adsorbed on Soil.	

	• Effects of Pollutants on the Chemistry of the Atmosphere, Hydrosphere, and Lithosphere.	
Unit II	**Physicochemical and Physical Treatment of Pollutants**	**15 lectures**
	• Chemistry Applied to the Analysis of Pollutants. • Chemistry Applied to the Treatment and Remediation of Pollution. • Physicochemical process- Redox Processes, Acid-Base/Hydrolysis, and Ion-Exchange Processes, Complexation Processes. Electrochemical Processes. • Physical Processes- Adsorption Processes, Radiation-Based Processes, Methods Based on Magnetic Fields, Filtration Methods.	

References

1. Ibanez, J. G., Hernandez-Esparza, M., Doria-Serrano, C., Fregoso-Infante, A., Singh, M. M. (2007). Environmental Chemistry: Fundamentals. Germany: Springer New York.
2. Manahan, Stanley E. Fundamentals of Environmental Chemistry Boca Raton: CRC Press LLC,2001
3. Environmental Chemistry by B. K. Sharma S. H. Kaur Goel Publishing House, Meerut
4. Environmental Chemistry - A.K. De, New Age Intt. Pub. Co., New Delhi, 1990
5. Toxic Chemicals, health and the Environment, Lave, L.B and Upton, A.C. 1987.
6. The Hopkins Press Ltd., London. Vogel's Textbook of quantitative Chemical analysis, 5th Edition-J. H. Basett, J. Nendham and Denny, R.C.
7. Instrumental Methods of analysis – Chatwal and Anand
8. Chemistry for Environmental Engineering, C. N. Sawyer and P L Mc Carty, McGraw Hill Kogakusha ltd., 1990
9. Fundamentals of Analytical Chemistry, 1982.Hobert H. Willard D.L. Merrit and J. R. J. A. Dean,

Course Name: VSC (Research Methodology)

Credits: 2 Type: Theory

Course Outcomes

On completion of this course, students will be able to

- Learn to formulate research problems, design studies, and apply appropriate methodologies for data collection and analysis.

● Gain proficiency in writing research papers, citing sources correctly, and adhering to ethical research practices.		
Unit I	**Introduction to Research fundamentals**	**15 lectures**
	● Meaning and Objectives of research. ● Types of research. ● Identification and formulation of research problems. ● Steps involved in the research process. ● Hypothesis and its types. ● Structuring a research project. ● Literature review and paraphrasing. ● Research ethics, Plagiarism and use of plagiarism detection softwares.	
Unit II	**Data Collection, Hypothesis and Research reporting**	**15 lectures**
	● Classification of data. ● Sample size, Sampling procedure and methods. ● Methods of data collection. ● Introduction to Bioinformatics. ● Reporting and Technical writing. ● Abstract writing, types of abstracts, styles of citation, references.. ● Types of research reports. ● Role of AI in research.	

References

1. Thomas, C. G. (2021). Research Methodology and Scientific Writing. Germany:
2. Springer International Publishing.
3. Kumar, R. (2010). Research Methodology: A Step-by-Step Guide for Beginners.
4. United Kingdom: SAGE Publications.
5. Research Methodology: A Handbook for Beginners. (2017). (n.p.): Notion Press.
6. Research Methodology: A Practical and Scientific Approach. (2019). United States: CRC Press.

Marks Distribution for Four Year Multidisciplinary Undergraduate Program with Department Specific Core as Major (Environmental Science) and Minor (Chemical and Biological Sciences) in TYBSc Semester-V

Paper	Internals	Semester end Theory	Practicals	Total
DSC Major - I	25	50	25	100
DSC Major - II	25	50	25	100
DSC Major - III	25	50	25	100
DSE – I, II	25	50	25	100
Minor	20	30	-	50
VSC	50	-	-	50
FP	50	-	-	50

Semester VI
Core Course\Vocational Skill Enhancement Course\ Skill Enhancement Course\Open Elective\AEC\IKS\VEC

Name of Program: B.Sc. Environmental Science				**Name of Department:**		
Class	**Semester**	**Course Type**	**Course Name**	**Course Code**	**No. of lectures/ per week**	**Credits**
TYBSc	VI	Major DSC - I	Environment Management Systems	SIUESMJ321 (T); SIUESMJP321 (P)	3T + 1P	4
TYBSc	VI	Major DSC - II	Environmental Toxicology and Risk Assessment	SIUESMJ322 (T); SIUESMJP322 (P)	3T + 1P	4
TYBSc	VI	Major DSC - III	Restoration Ecology	SIUESMJ323 (T); SIUESMJP323 (P)	3T + 1P	4
TYBSc	VI	Major DSE - II	Environmental Entrepreneurship Development	SIUESEL322 (T); SIUESELP322 (P)	3T + 1P	4
TYBSc	VI	Minor	Environmental Health and Control of Diseases	SIUESMN321	2T	2
TYBSc	VI	OJT	–	SIUESOJ321	–	4

Course Name: Major DSC 1: Environment Management Systems Credits: 3 Type: Core		
Course Outcomes On completion of this course, students will be able to ● Gain knowledge on guidelines of the environmental management system. ● Acquire the basic understanding of the audit processes. ● Understand the present scenario of development and environment.		
Unit I	**Environment Management systems and EIA**	**15 lectures**
	● Introduction to Environment Management. ● EMS - features, tools. ● Definition and concept of EIA ● Aims and objectives in EIA ● Stages in EIA	
Unit II	**ISO, Environmental Audit and LCA in EMS**	**15 lectures**
	● ISO 14000 series, principles and methodology ● ISO 16000, ISO 45000, ISO 50000 ● Introduction to environmental audit ● Features and Objectives of environmental audit ● Environmental audit process ● Types of environmental audit ● LCA - Evolution, cradle to grave approach, procedure, application of LCA ● Circular Economy	
Unit III	**Concept of Carbon Credits, Eco-Designs and Clean Production**	**15 lectures**
	● Kyoto protocol ● CDM ● Carbon credits and carbon bank ● Clean production	

	• Preparation, Strategy, Business model, Implementation and review • Eco-designs

Course Name: Major DSC 1 Practical (Environment Management Systems) Credit: 1
Course Outcomes On completion of this course, students will be able to: • Understand challenges associated with sustainable development. • Analyse and summarise the reports on LCA, EIA. • Apply skills to undertake Environmental Audit.

Practical No.	Title
1.	Study of an EIA procedure for a road project/dam/industry (case study).
2.	Study of PDCA cycle of ISO 14000.
3.	Preparation of a report on environmental audit.
4.	Life cycle analysis of a product of daily use.
5.	Questionnaire based survey on utilisation of eco-friendly products.

References

1. Camborne D F, 1997 Environmental Life Cycle Analysis, Lewis Publishers
2. Jadhav H.V. Environmental management, Vipul Prakashan, Mumbai
3. Uberoi N.K. Environmental Management, Excel Book, Delhi
4. Sheldon, C., & Yoxon, M. (2012). Environmental management systems: a step-by-step guide to implementation and maintenance. Routledge
5. Tinsley, S., & Pillai, I. (2012). Environmental management systems: understanding organisational drivers and barriers. Taylor & Francis.
6. Krishna, I. M., Manickam, V. (2017). Environmental Management: Science and Engineering for Industry. India: Elsevier Science.
7. Kalam APJ, Singh, Penguin India (2011). Target 3 Billion: Innovative Solutions Towards Sustainable Development
8. Guinée, J. B., & Lindeijer, E. (Eds.). (2002). Handbook on life cycle assessment: operational guide to the ISO standards (Vol. 7). Springer Science & Business Media.
9. Klöpffer, W., & Grahl, B. (2014). Life cycle assessment (LCA): a guide to best practice. John Wiley & Sons.
10. Jackson, S. L. (1997). The ISO 14001 implementation guide: creating an integrated management system (Vol. 3). John Wiley & Sons.

Course Name: Major DSC 2 (Environmental Toxicology and Risk Assessment)

Credits: 3 Type: Core

Course Outcomes

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

- Understand the concept of toxins and toxicity.
- Calculate and assess the effects of toxins on biological organisms
- Assess risk associated with toxins

Unit I	**Toxic elements in the Environment**	**15 Lectures**
	• Introduction - Toxins, Toxicity, and Toxicology. • Toxic elements in the air. • Toxic elements in water - freshwater, marine water, groundwater, and wastewater. • Toxic elements in soil. • Impact of toxic chemicals and enzymes in living systems. • Case studies - Bhopal gas tragedy, Three mile island disaster, Love Canal disaster, Minamata disease case, Itai Itai disease case.	
Unit II	**Toxicology, Microbiology and Biodegradability**	**15 Lectures**
	• Absorption, distribution, and excretion of toxic agents. • Dose Response Curve. • Acute and chronic toxicity. • Bioassay and threshold limit value. • Therapeutic index. • Margin of safety. • Epidemiological issues - fluorosis, arsenicosis. • Biodegradation, Microbial transformation - bio oxidation, bio reduction, bio hydrolysis.	
Unit III	**Environmental risk assessment**	**15 Lectures**
	• Risk assessment - Hazard Identification, Exposure Assessment, Dose response Assessment, Risk Characterization. • Risk matrix.	

	• Risk management strategies. • Risk management certification. • Air and water quality regulation, solid and toxic waste regulation. • Emission of toxins throughout the life cycle of a product.

Course Name: Major DSC 2 (Environmental Toxicology and Risk Assessment Practical)
Credit: 1

Course Outcomes

On completion of this course, students will be able to

- Understand qualitative analysis for toxins.
- Determine the relationship between exposure and effective dose
- Estimate of toxicants
- Identify symbols associated with toxicology
- Effect of toxins on living organisms through observational study

Practical No.	Title
1.	Analysis of heavy-metal in given water and soil samples.
2.	Determination of LC 50 value.
3.	Estimation of toxicant by agar diffusion assay.
4.	Identification of symbols associated with toxicology and risk assessment.
5.	Seed germination toxicity test to understand NOAEL and LOAEL.

References

1. Advanced Environmental Chemistry. (2017). India: Energy and Resources Institute.
2. Casarett & Doull's Toxicology: The Basic Science of Poisons, 9th Edition. (2018). Greece: McGraw-Hill Education.
3. Ahluwalia, V. K. (2016). Environmental Studies: Basic concepts. India: Energy Resources Institute.
4. Environmental Toxicology: Selected Entries from the Encyclopedia of Sustainability Science and Technology. (2012). United States: Springer New York.
5. Welbourn, P., Wright, D. A. (2002). Environmental toxicology. United Kingdom: Cambridge University Press.

6. A Handbook of Environmental Toxicology: Human Disorders and Ecotoxicology. (2020). United Kingdom: CABI.
7. Shaw, I., Chadwick, J. (2018). Principles of Environmental Toxicology. United Kingdom: CRC Press.
8. New Frontiers in Environmental Toxicology. (2021). Switzerland: Springer International Publishing.
9. Lerche, I., Glaesser, W. (2007). Environmental Risk Assessment: Quantitative Measures, Anthropogenic Influences, Human Impact. Germany: Springer Berlin Heidelberg.
10. Simon, T. (2019). Environmental Risk Assessment: A Toxicological Approach. United States: CRC Press.
11. Theodore, L., Dupont, R. R. (2012). Environmental Health and Hazard Risk Assessment: Principles and Calculations. United States: CRC Press

Course Name: Major DSC 3 (Restoration Ecology)

Credits: 3 Type: Core

Course Outcomes

On completion of this course, students will be able to

- Articulate the concept of restoration and historical development.
- Describe the major ecological principles and techniques of forest and freshwater restoration.
- Assess and understand ecological restoration measures for urban ecosystems.

Unit I	**Introduction to Restoration**	**15 lectures**
	• IKS-II: Traditional Resource Management Practices • Modern practices impacting resources; Need for restoration • Definition, Principles of Restoration • Significance of Restoration • Strategies and Guidelines of Ecological Restoration • Restoration Plan and Rehabilitation Measures • Understanding Limitations i) Biological Limitations ii) Physical Limitations iii) Chemical Limitations • Contributions of individuals in restoration activities.	
Unit II	**Forest and Freshwater Restoration**	**15 lectures**
	Forest Restoration:	

	• Degraded forest patches • Wetland and Mangroves restoration • Grasslands restoration • Plant and Animal Reintroduction **Freshwater Restoration**: • Ponds restoration • Lakes restoration • River restoration • Traditional water harvesting structures such as *nadis*, Khadin, Rapats, Lakes, etc. contour bunding, graded bunds /field bunds, land levelling or terracing, farm ponds	
Unit III	**Restoration of Urban ecosystem**	**15 lectures**
	• Urban Issues - Transportation, Industrial areas; Sustainable transportation • Urban forestry • Green belts in urban areas • Bioremediation as a method of restoration • Restoration of soil in urban areas • Restoration of dumping grounds • Coastal restoration, land reclamation • Case studies of urban areas from India	

Course Name: Major DSC 3 Practical (Restoration Ecology Practical) Credit: 1	
Course Outcomes On completion of this course, students will be able to • Locate the watershed areas and understand features. • Articulate the state of eco restored and reclaimed areas. • Highlight the importance of urban green belts and other green spaces.	
Practical No.	**Title**
1.	Tracing of watersheds and their morphological features from toposheets.
2.	Report on eco-restored sites & reclaimed sites.

3.	Report of inventory maps and assessing current status of restored areas.
4.	Identification of green belts in urban areas and study their significance.

References

1. Ecology, Environmental Science & Conservation. (2014). India: S. Chand Pvt. Limited.
2. Restoration of Nature by Prakash Gole
3. Restoration Ecology the new frontier – edited by Jelte Van Andel and James Aronson – Wiley-Blackwell publication ISBN 9781444336368
4. A source book for Ecological Restoration, Foundation for Ecological Security 2008
5. Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series), Donald A. Falk, Margaret Palmer,Joy Zedler, Richard J
6. Soil and water conservation engineering by R. Suresh – Standard Publishers and Distributors ISBN 8180140008

Course Name: Major DSE II (Environmental Entrepreneurship Development)

Credits: 3 Type: Core

Course Outcomes

On completion of this course, students will be able to

- Identify opportunities for entrepreneurial ventures that address environmental challenges.
- Develop innovative business models that integrate environmental sustainability and effective communication skills to pitch business ideas.
- Understand the regulatory landscape and legal considerations relevant to environmental entrepreneurship and conduct market analysis and customer research to identify target markets.

Unit I	**Ecopreneurship and Entrepreneurship**	**15 lectures**
	• Introduction to Ecopreneurship. • Critical global challenges. • Concept of entrepreneurship, Characteristics of entrepreneurs. • Sustainable business models. • Eco-efficient and eco-effective design, products and services.	

	• Business plan, Strategy for a new green business, Positioning, Pitching, Bootstrapping. • SWOT Analysis & achievement motivation.	
Unit II	**Policy, regulations, Marketing and Business Development**	**15 lectures**
	• Government regulation of entrepreneurship in India: Ministry of Commerce and Industry, Ministry of Skill Development and Entrepreneurship, Ministry of MSME (Micro, Small and Medium Enterprises) • Government policy and programs & institutions for entrepreneurship development • Difference between marketing and business development, Role of marketing, role of business development. • Connecting with Customers- Customer Characteristics. • Market Research and Design Thinking, Branding and Pricing. • Strategies for Markets and Industries- Growth Strategies and examples.	
Unit III	**Intellectual Property Rights**	**15 lectures**
	• Different property rights & IPR in India. • TRIPS, WTO. • Patent laws, Trademark laws, Copyright laws. • Protection of traditional knowledge – Objective, concept of traditional knowledge, holders, issue concerning, bioprospecting and biopiracy. • International Depositary Authority, Gene patenting, Plant variety protection, Trade secrets & Plant breeders' right. • Standards and certification.	

Course Name: Major DSE II Practical (Environmental Entrepreneurship Development Practical) Credit: 1
Course Outcomes On completion of this course, students will be able to • Integrate environmental sustainability into business practices.

- Create networking and collaboration within the environmental sector.
- Understand the ethical and legal implications of patent filing.

Practical No.	Title
1.	Write a business plan for a sustainable business model.
2.	SWOT analysis of a Business Plan.
3.	Survey of any entrepreneur through questionnaire method and report preparation.
4.	Survey of customers from an entrepreneur point of view through questionnaire method and report preparation.
5.	Study of comparison between any two marketing plans.
6.	Drafting a provisional patent application.

References

1. Micro, Small and Medium Enterprises (MSMEs) in the Indian Economy: Business Development Strategies. (2009). India: New Century Publications.
2. Sugandhi, R. K. (2009). Business To Business Marketing. India: New Age International(p) Limited N Delhi.
3. Sabanna, T. (2007). WTO and Intellectual Property Rights. India: Serials Publications.
4. Bouchoux, D. E. (2012). Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets. United States: Delmar Cengage Learning.
5. Biodiversity, Biotechnology and Traditional Knowledge: Understanding Intellectual Property Rights. (2010). India: Narosa Publishing House

Course Name: Minor (Environmental Health and Control of Diseases)

Credits: 2 Type: Core (Theory)

Course Outcomes

On completion of this course, students will be able to

- Understand environmental health risks
- Examine the strategies associated with prevention and control of environmental diseases

Unit I	**Global and regional perspectives of environmental health**	**15 Lectures**

	• Concept of environmental health, significance of environment for human health. • Regional environment health concerns. • Global environment health concerns. • Policies and regulations with respect to environmental health concerns. • Environmental justice: disproportionate health impact on vulnerable populations.	
Unit II	**Environmental diseases and its control measures**	**15 Lectures**
	• Concept of epidemiology contribution of epidemiology to environmental health. • Air and Water borne diseases. • Arboviral disease. • Strategies for sustainable environmental health - green technology, community based interventions, climate adaptation and resilience. • Role of governments, NGOs and international collaborations in promoting environmental health.	

References

1. Friis, R. (2012). Essentials of Environmental Health. United States: Jones & Bartlett Learning..
2. Bisesi, M. S., Koren, H. (2002). Handbook of Environmental Health, Volume I: Biological, Chemical, and Physical Agents of Environmentally Related Disease. Ukraine: CRC Press.
3. Ronald M. Atlas, Stanley Maloy (2014). One Health - People, Animals and the Environment. Wiley
4. Megan Landon (2006). Environment. Health and Sustainable Development. McGraw Hill Education.

Marks Distribution for Four Year Multidisciplinary Undergraduate Program with Department Specific Core as Major (Environmental Science) and Minor (Chemical and Biological Sciences) in TYBSc Semester-VI

Paper	Internals	Semester end Theory	Practicals	Total
DSC Major - I	25	50	25	100
DSC Major - II	25	50	25	100
DSC Major - III	25	50	25	100
DSE – I, II	25	50	25	100
Minor	20	30	-	50
OJT	-	-	-	100