SIES College of Arts, Science & Commerce (Autonomous)
RISE WITH EDUCATION
NAAC REACCREDITED - 'A' GRADE

SIES Indian Institute of Environment Management
RISE WITH EDUCATION

Syllabus

Faculty: Science

Program: B.Sc.

Subject: ENVIRONMENTAL SCIENCES

Academic Year: 2023-2024

S.Y.B.Sc.

Credit Based Semester and Grading Syllabi
to be brought into effect from 2023- 2024

PREAMBLE

Environmental Sustainability is one of the dominant issues and challenges of the 21st century, as the over growing needs of the galloping global population increasingly pressing up against the limits of the earth's resources and ecosystems. At the same time, policy makers increasingly believe that an environmentally literate workforce is critical to the long-term success and profitability, with better environmental practices and improved efficiencies impacting positively on the bottom line while helping to better position the country and conserve the natural resources for the future. A key component of an environmentally sustainable country is a highly educated workforce, with thorough knowledge of theoretical and practical aspects of environmental sciences.

B.Sc. in Environmental Science is an undergraduate, interdisciplinary course wherein learning is imparted to eligible candidates in concepts such as sustainable resource development, environmental pollution control and management among others. This 3-year long course is divided into six semesters, with each semester lasting for a period of six months. The students opting for three years will be graduated with a Bachelor's Degree.

The course combines aspects of Biology, Ecology, Geography, Chemistry, Natural Resource Management, Environment Management etc. Students are taught to develop scientific knowledge and techniques needed to understand environmental patterns and processes to investigate ecosystems and address local and global environmental issues, besides investigating how Environmental Science is directly related to human society.

SEMESTER - III				
Course Code	**Course Type**	**Course Title**	**Credits**	**Lectures/Week**
SIUSEVST31	Core Subject	**Natural Resource Management**	2	3
SIUSEVST32	Core Subject	**Pollution Monitoring and Sampling**	2	3
SIUSEVST33	Core Subject	**Instrumentation and Analytical Techniques in Environmental Science**	2	3
SIUSEVST34	Core Subject	**Environmental Health and Control of Diseases**	2	3
SIUSEVST35	Core Subject	**Environmental Pollution Control and Management I**	2	3
SIUSEVST36	Core Subject	**Biostatistics**	2	3
SIUSEVST37	Ability Enhancement Course 1 (FC I)	**Research Methodology**	2	3
SIUSEVSP31 to SIUSEVSP36	Core Subject Practicals	**SIUSEVSP31 to SIUSEVSP36**	6	18
Total			**20**	**40**

SEMESTER - IV				
SIUSEVST41	Core Subject	**Environmental Pollution Control and Management II**	2	3
SIUSEVST42	Core Subject	**Solid Waste Management**	2	3
SIUSEVST43	Core Subject	**Environmental Toxicology and Risk Assessment**	2	3
SIUSEVST44	Core Subject	**Biosafety and Biohazard**	2	3
SIUSEVST45	Core Subject	**Environmental Policy and Regulations**	2	3
SIUSEVST46	Core Subject	**Green Technology**	2	3
SIUSEVST47	Ability Enhancement Course 1 (FC II)	**Computer Applications**	2	3
SIUSEVSP41 to SIUSEVSP46	Core Subject Practicals	**SIUSEVSP41 to SIUSEVSP46**	6	18
Total			**20**	**40**

Detailed Syllabus of B. Sc. Environmental Science

S. Y. B. Sc.

SEMESTER – III; Paper I

COURSE CODE	TITLE	LECTURES
SIUSEVST31	NATURAL RESOURCE MANAGEMENT	
Course Objective: The students will get acquainted with the different natural resources. **Learning Outcome:** The knowledge of the student will be upgraded in the area of resource management.		
Unit-I: Introduction to Natural Resources	● Definition, Classification of natural resources ● Distribution of natural resources (National and Global) ● Importance and application of natural resources ● Demands of Natural Resources due to Population, lifestyle. ● Need for natural resource management.	**15**
Unit II: Land and Forest Resources management	● Agricultural practices in India, exploitation of agricultural land, development of wasteland ● Land use changes in India (case studies), future demand of forest land ● Forest management practices: Afforestation, Joint Forest Management, Agroforestry, social forestry, urban forestry, protected forest area management. (Case studies).	**15**
Unit III: Water and Mineral Resource	● Water and Mineral Resources Management - Concept and classification ● Management Practices: Integrated water resource management; Watershed development; Rainwater harvesting. National Lake and River Conservation Programmes. ● Wetland management. Coastal zone management- concept, scope, issues and strategies. ● Implications of National River linking programme on environment. ● Conservation of Mineral resources of India. Oceans as new areas for exploration of mineral	**15**

	resources. Oceans ore and recycling of resources. ● Case studies.	

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP31	**NATURAL RESOURCE MANAGEMENT**	**1**	**15**

1. Estimation of energy content in solid and liquid energy resources A) Petrol and diesel b) Husk, fodder, and wood.
2. Study of selected exotic species of India.
3. Estimation of Phenol by bromination.
3. Plotting of areas rich in mineral ore on map of India.
4. Energy consumption pattern 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.

SEMESTER – III; Paper II

COURSE CODE	TITLE	LECTURES
SIUSEVST32	**POLLUTION MONITORING AND SAMPLING**	
Course Objective: To introduce the students to different pollution monitoring techniques. **Learning Outcome:** Students will be able to understand the technique of collecting and analyzing air, water, soil and noise samples.		
Unit-I: Air monitoring and sampling	● **Monitoring of air quality-** Station based monitoring, satellite-based monitoring ● **Techniques of air monitoring** - Stack gas/dust Sampling technique, Dust Fall Jar, SPM and RSPM using Respirable Dust sample/High Volume Air Sampler (Ambient Air monitoring). ● Monitoring of exhaust emissions, Automobile pollution in Indian cities (case studies) ● **Sampling** - Objective and Criteria of Air Sampling, Selection of Sampling Location ● **Sampling Methods** - Sedimentation, Filtration, Centrifugal and Impingement Method.	**15**
Unit II: Water monitoring and sampling	● Objectives, Selection of Sampling Site, Types of Water Samples, Collection, Handling and Preservation, Sampling Equipment, ● Classification of Water Quality Parameters (Inorganic, Organic and Nutrient), Parameters analyzed on the Spot, (Field Parameters) ● Basic Concept, Significance and Measurement of DO, BOD, COD, Phenol, Pesticides and Polynuclear Aromatic Hydrocarbons (PAHs) in Water and Wastewater.	**15**
Unit III: Soil and noise monitoring and sampling	● Objectives of Soil Sampling, Site Selection Criteria, Collection and Handling of Soil Samples ● Preparation of Soil Samples for Analysis, ● Measuring Physico-Chemical Parameters and their Significance (Quality and Productivity) of soil.	**15**

	• Objectives of noise monitoring, noise monitoring system, noise monitoring equipment.	

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP32	**POLLUTION MONITORING AND SAMPLING**	**1**	**15**
1. Determination of SO_X and NO_X in ambient air using RDS/HVS. 2. Determination of noise monitoring in selected areas using a sound level meter. 3. Estimation of Fluoride content in water samples. 4. Determination of oil and grease content in polluted water samples. 5. Air, water and noise pollution - case studies from India.			

References:

1. Lodge. (1994). Methods of air sampling and analysis
2. Kudesia V.P. (1993). Air Pollution, Pragati Prakashan, New Delhi.
3. Mishra P.C. (1989). Soil Pollution and Soil Organisms.
4. Goel P.K. (1997) Water Pollution-Causes, Effects & Control. Techno Science Pub., Jaipur.

SEMESTER – III; Paper III

COURSE CODE	TITLE	LECTURES
SIUSEVST33	**INSTRUMENTATION AND ANALYTICAL TECHNIQUES IN ENVIRONMENTAL SCIENCE**	
Course Objective: To acquaint the students with the various analytical instruments. **Learning Outcome:** The students will learn the various analytical techniques and instruments useful in study of environmental parameters.		
Unit-I: : Introduction to Ecological Instruments	**Principle, Construction, Working and Applications of**: - Audio dosimeter, Wet-bulb globe temperature, Piston pump or bellows pump with an attached detector, Glass tube containing a solid adsorbent, High-flow vacuum air sampler & two-stage cascade impactor, Rain Gauge, Lux meter, High-flow or multi-flow air sampling pumps, pocket ionization chamber, Geiger–	**15**

	Müller meter, Swinging-vane anemometer, Thermal or hot wire velometer, Electrostatic precipitator, Cyclone separator.	
Unit II: Methods of Separation	● **Analytical separation-** Types of separation methods: 1. Based on Solubilities 2. Based on Gravity 3. Based on volatility, 4. Based on Electrical Effects 5. Based on retention capacity of a Stationary Phase, 6. Based on distribution in two immiscible phases, 7. Based on capacity to exchange with a resin. ● **Solvent extraction**- Introduction, Conditions of extraction, Single step and multi-step extraction, Batch and continuous extraction. ● **Chromatography** - Introduction to Chromatography, Classification based on stationary and mobile phase, Paper Chromatography, Thin layer Chromatography, HPLC.	**15**
Unit III: Optical Methods	● Atomic Spectroscopy- Introduction, Energy level diagram, Absorption and emission spectra ● Principle, Instrumentation, Applications - i) Flame Photometry ii) Atomic Absorption spectroscopy ● Principle, Instrumentation, Applications - i) Colorimetry ii) Spectrophotometers ● Principle, Instrumentation, Applications - i) Turbidimetry ii) Nephelometry	

Practicals:

COURSE CODE	**TITLE**	**CREDITS**	**HOURS**
SIUSEVSP33	**INSTRUMENTATION AND ANALYTICAL TECHNIQUES IN ENVIRONMENTAL SCIENCE**	**1**	**15**
1. Separation of a mixture of chlorophyll pigments by paper chromatography. 2. Separation of a mixture of carotenoids by TLC. 3. Estimation of nitrate in water sample by UV spectrophotometer. 4. Identification of ecological instruments.			

References:

1. Handbook of environmental health, biological, chemical, physical agents of environmentally related diseases. Herman Koren, Michael Bisesi
2. Skoog et al. “Fundamentals of Analytical chemistry" Cengage Learning, Eight Edition.

3. Gary D. Christian," Analytical Chemistry", VIth Edition, Wiley Students Edition
4. Principles of Instrumental Analysis by Skoog, Holler, Nieman, 5th Edition pp
5. Handbook of methods in Environmental studies, water and wastewater analysis, S K Maiti.

SEMESTER – III; Paper IV

COURSE CODE	TITLE	LECTURES
SIUSEVST34	**ENVIRONMENTAL HEALTH AND CONTROL OF DISEASES**	
Course Objective: To acquaint the students with the basic knowledge of environmental health and diseases. **Learning Outcome:** The knowledge of students will be upgraded in the field of environmental disease control.		
Unit-I: Global and regional perspectives of environmental health	● Concept of environmental health, Significance of environment for human health ● Global environment health concerns ● Regional environment health concerns ● Chemical, biological and radioactive terror threats	**15**
Unit II: Environmental Diseases	● Water borne diseases – leptospirosis, poliomyelitis, scabies ● Air borne diseases – tuberculosis, pneumonia, influenza ● Arboviral diseases – malaria, dengue, trypanosomiasis ● Zoonotic diseases and emerging zoonoses ● Case studies of environmental diseases	**15**
Unit III: Control measures of Environmental Diseases	● Concept of epidemiology, Contribution of epidemiology to environmental health ● Integrated vector management ● Prevention and control of environmental diseases	**15**

Practical:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP34	**ENVIRONMENTAL HEALTH AND CONTROL OF DISEASES**	**1**	**15**
1. Estimation of chromium in water sample spectrophotometrically. 2. Estimation of residual chlorine from drinking water using colorimetric method. 3. Identify the diseases prevailing in different states of India through meteorology. 4. Identification of different vectors of diseases.			

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, Animal and the Environment. Wiley
4. Megan Landon (2006). Environment. Health and Sustainable Development. McGraw Hill Education.

Semester – III; Paper V

COURSE CODE	TITLE	LECTURES
SIUSEVST35	**ENVIRONMENTAL POLLUTION CONTROL AND MANAGEMENT I**	
Course Objective: To acquaint the student with the basic concept of pollution, focusing on air and water pollution. **Learning Outcome:** Students will acquire the knowledge of air and water pollution prevention and management.		
Unit-I: Introduction to Air Pollution	● Sources of air pollution, classification of air pollutants ● Effect of air pollution - on plants, animals, human health, environment and material. Case studies. ● Indoor air pollution, causes and effect ● Acid rain and its effects. Case studies. ● Concept of air quality standards, Ambient air quality standards, NAAQS, AQI, vehicular emission norms	**15**
Unit II: Water pollution	● Sources of water pollution, classification of water pollutants. ● Types of water pollution - Groundwater pollution, Surface water pollution, Marine pollution ● Effect of different types of water pollution - on aquatic and terrestrial flora, fauna, human health. Case studies. ● Oil spills, thermal pollution and its effects. Case studies	**15**

	● Concept of water quality standards, Water quality standards, Water quality criteria, Water quality index in India.	
Unit III: Control of air and water pollution	**Air Pollution Control** ● **Control for particulate matter** - Gravitational Settling, Cyclonic Separation, Filtration, Wet Scrubbing, Electrostatic precipitation ● **Control for VOCs** - Absorption in suitable liquids, Condensation, Adsorption, Incineration ● **Control for gaseous emissions –** NO_2, SO_2, recent case studies. **Water Pollution Control** ● **Physical unit process**, - Screening, Flocculation, Sedimentation, Filtration ● **Chemical unit process -** Chemical Precipitation, Adsorption process, Disinfection process ● **Biological unit process -** Role of Micro-organism, Activated sludge process, Aerated lagoons, Stabilization ponds, Trickling Filters, Sludge management. ● **Advance wastewater treatment processes -** Ion – exchange process, Reverse Osmosis, Electro-dialysis, Carbon Adsorption ● Concept of Zero waste discharge.	**15**

Practicals:

COURSE CODE	**TITLE**	**CREDITS**	**HOURS**
SIUSEVSP35	**ENVIRONMENTAL POLLUTION CONTROL AND MANAGEMENT I**	**1**	**15**
1. Estimation of MLSS, MLVSS and SVI from activated sludge. 2. Estimation of Dissolved Oxygen and Biochemical Oxygen Demand in water samples. 3. Estimation of Chemical Oxygen Demand in water sample. 4. Estimation of particulate matter in ambient air by personal air sampler. 5. Determination of Foliar dust capturing capacity of different plant species.			

References:

1. Sharma B.K :(2001), Environmental Chemistry, GOEL Publishing House, Meerut(UP)
2. Trivedi, P. R. (2004). Environmental Pollution and Control. India: APH Publishing Corporation.

3. Khopkar, S. M. (2007). Environmental Pollution Monitoring and Control. India: New Age International (P) Limited.
4. Singal, S. (2012). Air Quality Monitoring and Control Strategy. United Kingdom: Alpha Science International Limited.

SEMESTER – III; Paper VI

COURSE CODE	TITLE	LECTURES
SIUSEVST36	**BIOSTATISTICS**	
Course Objective: To introduce the students to the statistical aspects and highlight its importance in environmental research. **Learning Outcome:** The course will enable the learners to understand the basic statistical concepts, right from data collection, representation to analyzing the data using various statistical tools appropriately.		
Unit-I: : Introduction to Biostatistics- Sampling, Data collection and Representation	• Importance of biostatistics • Population and Sample; Sampling methods • Variables • Meaning of data, Arrangement and grouping of data, Creating a data set • Bar chart; Pie chart • Frequency polygon & Histogram	**15**
Unit II: Measures of Central tendency and Dispersion	• Mean (Arithmetic, Geometric) • Median • Mode • Range of data • Absolute deviation, Variance & Standard deviation • Coefficient of variation	**15**
Unit III: Statistical tests for Data analysis	• Inferential statistics, Degree of freedom, Statistical Assumptions • Variables and their types • Hypothesis testing • Correlation • Regression Analysis • t-test • ANOVA • Chi-square	**15**

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP36	BIOSTATISTICS	1	15

1. Collection, arrangement and grouping of data; representation of data in the form of bar chart, pie chart, frequency polygon and histogram.
2. Calculation of mean, median, mode, standard deviation from the collected data.
3. Calculation of Coefficient of correlation from given data.
4. Regression Analysis using the given data.
5. Chi-square test of given data.

References:

1. Text Book of Biostatistics I. (2005). India: Discovery Publishing House Pvt. Limited.
2. Kulkarni, A. P. (2019). Basics of Biostatistics. India: CBS Publishers & Distributors.
3. Lee, E. S., Forthofer, R. N. (2014). Introduction to Biostatistics: A Guide to Design, Analysis, and Discovery. United States: Elsevier Science.
4. Suresh, S. (2016). Research Methodology and Biostatistics - E-book: A Comprehensive Guide for Health Care Professionals. India: Elsevier Health Sciences.
5. ESSENTIALS OF BIOSTATISTICS: FOR UNDERGRADUATE, POSTGRADUATE STUDENTS OF MEDICAL SCIENCE, BIOMEDICAL SCIENCE AND RESEARCHERS. (2016). (n.p.): Academic Publishers.
6. Topics in Biostatistics. (2007). United Kingdom: Humana Press.
7. Pandey, M. (2015). Biostatistics: Basic and Advanced. India: Viva Books Private Limited.
8. Al-Shiha, A., Islam, M. A. (2018). Foundations of Biostatistics. Singapore: Springer Nature Singapore.
9. ESSENTIALS OF BIOSTATISTICS & RESEARCH METHODOLOGY. (2020). (n.p.): Academic Publishers.
10. Le, C. T., Eberly, L. E. (2016). Introductory Biostatistics. Germany: Wiley.

SEMESTER III; Paper VII

COURSE CODE	TITLE	LECTURES
SIUSEVST37	RESEARCH METHODOLOGY	

Course Objective: To orient the students to the research arenas in a systematic way.

Learning Outcome: The learners will be able to have a systematic approach to resolve environmental problems by setting up a hypothesis followed by designing techniques and reporting the observations after suitable experiential work.

Unit-I: Introduction to Research fundamentals	• Meaning and Objectives of research • Types of research • Identification and formulation of research problem • Steps involved in research process • Structuring a research project • Literature review and paraphrasing • Research ethics- Plagiarism and use of plagiarism detection softwares	**15**
Unit II: Data collection, Analysis and Hypothesis	• Classification of data • Methods of data collection • Sample size • Sampling procedure and methods • Types of hypotheses; Hypotheses testing (parametric & non-parametric) • Errors & their control • Use of statistical softwares and packages	**15**
Unit III: Research reporting and Technical writing	• Abstract writing, types of abstracts, styles of citation, references, difference between Harvard Style and Numeric style • Types of research reports • Structure and organization of research reports • Reference managing softwares • Responsibilities and accountability of researchers	**15**

References:

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

SEMESTER IV

SEMESTER IV; PAPER I

COURSE CODE	TITLE	LECTURES
SIUSEVST41	**ENVIRONMENTAL POLLUTION CONTROL AND MANAGEMENT II**	
Course Objective: To acquaint the students with the emerging environmental concerns of pollution. **Learning Outcome:** Students will gain the knowledge regarding soil, noise and radioactive pollution prevention and management.		
Unit-I: Soil pollution Control and Management	● Soil pollution- natural and anthropogenic causes, classification of soil pollutants. ● Agriculture practices affecting soil, mining and quarrying are major concerns for soil pollution. Case studies. ● Effect of soil pollution - on plants, animals, human health, environment and material. Case studies. ● Control and prevention of soil pollution: control over the use of agrochemicals, integrated pest management, sustainable agricultural practices, sanitary landfill method, phytoremediation.	**15**
Unit II: Noise pollution Control and Management	● Concept of noise, sound measuring unit ● Noise pollution – Definition, Sources of noise pollution ● Effect of noise pollution - on plants, animals, human health and material. ● Urban cases of noise pollution ● Noise prevention measures ● Noise standards, WHO prescribed levels of noise, CPCB sound level standards	**15**
Unit III: Radioactive pollution Control and Management	• Definition - Radioactivity, radionuclide, radiation emission • Radioactive pollution – definition, sources of emission of radiations • Effect of radioactive pollution – on plants, animals, human and environment • Radioactive fallouts and its effect	**15**

	• Radioactive pollution episodes – Hiroshima and Nagasaki, Chernobyl disaster, Fukushima disaster • Control and prevention of radioactive pollution: control of X-ray radiations, disposal of radioactive waste, safety measures at nuclear power plant, individual preventive measures, nuclear reactor operation • Policies governing regulation of nuclear and radioactive safety of India.	

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP41	ENVIRONMENTAL POLLUTION CONTROL AND MANAGEMENT II	1	15

1. Estimation of phosphates in soil samples.
2. Determination of SAR value of soil.
3. Estimation of sulfates in a given sample.
4. Detection of radiation in different objects and environments.

References:

1. Sharma B.K :(2001), Environmental Chemistry, GOEL Publishing House, Meerut (UP)
2. Trivedi, P. R. (2004). Environmental Pollution and Control. India: APH Publishing Corporation.
3. Khopkar, S. M. (2007). Environmental Pollution Monitoring and Control. India: New Age International (P) Limited.
4. Environment pollution control and management - Indira Gandhi National Open University, school of interdisciplinary and trans disciplinary studies.
5. Soil Pollution: From Monitoring to Remediation. (2017). Netherlands: Elsevier Science.
6. Chemistry, Emission Control, Radioactive Pollution, and Indoor Air Quality. (2011). Croatia: IntechOpen.

SEMESTER – IV; Paper II

COURSE CODE	TITLE	LECTURES
SIUSEVST42	**SOLID WASTE MANAGEMENT**	
Course Objective: To acquaint the students with the basic concept of solid waste and management. **Learning Outcome:** Students will be able to manage the household waste and their knowledge will be upgraded in the field of hazardous waste.		
Unit-I: Introduction to solid waste, collection and storage of municipal solid waste	● Sources and generation of solid waste, Types of solid waste ● Classification based on composition, Characterization of waste. ● Factors affecting solid waste management. ● Impact of solid waste on environment, animals, plants and human health, ● Different techniques used in collection, transport, and storage of municipal solid waste.	**15**
Unit II: Management of Solid Waste	● Different methods of solid waste treatment and disposal- Introduction to Vermiculture, Composting, Landfill (Site Selection, Site Investigation and Site Characterization), Landfill Planning and Designing, Construction and Operational Practices, Landfill Quality and Control. ● Methods of disposal- incineration, pyrolysis. ● Concept of Integrated Waste Management (Case study). Zero waste concept of solid waste management. Concept of 12R's ● Green techniques for waste treatment, Concept of waste to energy recovery in India (case study)	**15**
Unit III: Hazardous and biomedical waste and its management	**Hazardous waste** ● Characterization of hazardous waste ● Storage of hazardous waste, treatment and disposal of hazardous waste – stabilization, solidification, incineration, landfill ● Impact of hazardous waste on environment and human health **Biomedical waste**	**15**

	• Characterization of bio-medical waste • Collection, storage, treatment and disposal of bio-medical waste • Impact of improper biomedical waste management	

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP42	**SOLID WASTE MANAGEMENT**	**1**	**15**

1. Solid waste management-collection and physico-chemical analysis of solid waste characterization and classification of waste.
2. Composting methods – Pit/Vermicompost.
3. Estimation of C:N ratio in compost.
4. Design aspects of incinerators, Sanitary landfill site, Biogas plant.
5. Waste generation pattern – questionnaire and survey.

References:

1. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. John Wiley & Sons.
2. Asnani, P. U. 2006. Solid waste management. India Infrastructure Report 570.
3. Blackman, W.C. 2001. Basic Hazardous Waste Management. CRC Press.
4. McDougall, F. R., White, P. R., Franke, M., & Hindle, P. 2008. Integrated Solid Waste Management: A Life Cycle Inventory. John Wiley & Sons.
5. US EPA. 1999. Guide for Industrial Waste Management. Washington D.C.
6. White, P.R., Franke, M. &Hindle P. 1995. Integrated Solid waste Management: A Life cycle Inventory. Blackie Academic & Professionals.
7. Zhu, D., Asnani, P.U., Zurbrugg, C., Anapolsky, S. & Mani, S. 2008. Improving Municipal Solid waste Management in India. The World Bank, Washington D.C.

SEMESTER – IV; Paper III

COURSE CODE	TITLE	LECTURES
SIUSEVST43	**ENVIRONMENTAL TOXICOLOGY AND RISK ASSESSMENT**	
Course Objective: To acquaint the students with the basic concept of toxicants in the environment. **Learning Outcome:** Knowledge of the student will be upgraded with respect to safety, precautions from toxic hazards.		
Unit I: Chemicals in the Environment	● Toxic chemicals in the air ● Toxic elements in water – freshwater, marine water, ground water and wastewater ● Toxic waste in soil ● Impact of toxic chemicals on enzymes in living systems ● Environmental episodes – Bhopal Gas Tragedy, Three Mile Island Disaster, Love Canal disaster, Minamata Disease, Itai Itai disease, Blue baby syndrome	**15**
Unit II: Toxicology, Microbiology and Biodegradability	● Absorption, distribution and excretion of toxic agents ● Acute and chronic toxicity ● Bioassay and threshold limit value ● Margin of safety ● Therapeutic index ● Epidemiological issues – Fluorosis, Arsenicosis ● Principles of Biodegradation ● Microbial Transformations – Bio-oxidations, Bio-reductions, Bio-hydrolysis	**15**
Unit III: Environmental Risk Assessment	● Risk analysis – assessment and management, risk management certification, risk matrix ● Air and water quality regulation, solid and toxic waste regulation ● Life Cycle Assessment (LCA) of products	**15**

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP43	**ENVIRONMENTAL TOXICOLOGY AND RISK ASSESSMENT**	**1**	**15**

1. Analysis of heavy metals in given water and soil samples.
2. Determination of LC_{50} value.
3. Estimation of any toxicant by agar diffusion assay.
4. Identification of symbols associated with toxicology and risk assessment.

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 and 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

SEMESTER – IV; Paper IV

COURSE CODE	TITLE	LECTURES
SIUSEVST44	**BIOSAFETY AND BIOHAZARD**	
Course Objective: To acquaint the students with biohazards and its control. **Learning Outcome:** Knowledge of the student will be upgraded in the field of biohazard identification assessment and its control.		
Unit-I: Biological Safety Considerations and Guidelines	● Introduction and concept of biosafety ● Biosafety considerations for plant pathogens ● Plant associated microorganisms significant to human health ● Biosafety guidelines in different work environments ● Global Harmonized System for Pictogram Purple book of UN	**15**
Unit II: Biohazard Identification and Assessment	● Microbial virulence factors ● Laboratory associated infections ● Risk assessment of biological hazards ● Assessment of microbial pathogenic agents ● Allergens from biological sources	**15**
Unit III: Control of Biohazards	● Design of various work environments to control biohazards ● Personal protection for workers against biohazards ● Standard precautions for handling and decontamination of probable bio-contaminants ● Packaging and shipping of biological materials. ● Development of biorisk management program ● Regulatory impact of biosafety and biosecurity.	**15**

Practicals:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP44	**BIOSAFETY AND BIOHAZARD**	**1**	**15**
1. Determination of aeromicroflora in different environments. 2. Identification of symbols used to indicate biosafety. 3. Disposal of electrophoretic gels/ carcinogenic compounds.			

References:

1. Ta, L., Gosa, L., & Nathanson, D. A. (2019). *Biosafety and biohazards: understanding biosafety levels and meeting safety requirements of a biobank* (pp. 213-225). Springer New York.
2. Burnett, L. C., Lunn, G., & Coico, R. (2009). Biosafety: guidelines for working with pathogenic and infectious microorganisms. *Current protocols in microbiology*, *13*(1), 1A-1.
3. Munusami, R., & Ramasamy, M. (2022). Recent Trends Toward the Development of Biosensors for Biosafety and Biohazards. In *Miniaturized Biosensing Devices: Fabrication and Applications* (pp. 333-349). Singapore: Springer Nature Singapore.
4. Biological Safety: Principles and Practices. (2020). United States: Wiley.

SEMESTER – IV; Paper V

COURSE CODE	TITLE	LECTURE
SIUSEVST45	**ENVIRONMENTAL POLICY AND REGULATIONS**	
Course Objective: To introduce students to the environmental acts, rules and international environmental treaties. **Learning Outcome:** The knowledge of the student will be updated in the field of National and international efforts taken for environmental causes.		
Unit-I: Introduction to Acts and Rules	● Introduction to Act and Rule; History of inclusion of environment as a part of the Constitution; Amendments and their implementation; ● National Environmental Policy; ● Environmental Regulation Framework in India;	**15**

	• Constitutional perspective; Fundamental rights & duties and Directive principles of state policy	
Unit II: Environmental Legislation	• Indian Forest Act, 1927 • Indian Wildlife (Protection) Act, 1972 • UNFCCC- Kyoto Protocol 1997; Paris Agreement • Water (Prevention and Control of Pollution) Act, 1974 • Forest Conservation Act, 1980 • Air (Prevention and Control of Pollution) Act, 1981 • Environment Protection Act, 1986 • Public Liability Insurance Act, 1991 • Bio-Medical Waste (Management and Handling) Rules, 1998 • Noise Pollution (Regulation and Control) Rules, 2000 • Municipal Solid Waste (Management and Handling Rules), 2000 • Biodiversity Act, 2002 • Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003 • The Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 • National Green Tribunal Act, 2010 • Coastal Regulation Zone (CRZ) Rules, 2011	**15**
Unit III: International Conventions and Treaties	• Stockholm Conference 1972; • Vienna Convention 1985; • Montreal Protocol 1987; • Basel Convention 1989; • Earth Summit 1992; • Convention on Desertification 1996;	**15**

Practical:

COURSE CODE	TITLE	CREDITS	HOURS
SIUSEVSP45	**ENVIRONMENTAL POLICY AND REGULATIONS**	**1**	**15**
1. Study any 3 legal case studies on violation of the Air Act. 2. Study any 3 legal case studies on violation of the Water Act. 3. Study any 3 legal case studies on violation of the Biodiversity 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.

SEMESTER – IV; Paper VI

COURSE CODE	TITLE	LECTURES
SIUSEVST46	**GREEN TECHNOLOGY**	
Course Objective: To introduce the students to the basic concept of green technology and its application. **Learning Outcome:** Students will gain knowledge about green practices which are the need of the present day.		
Unit-I: Concept of green technology	● Definition and concept of green technology ● Green energy, green chemistry, green economy. ● Agenda of green technology - Energy conservation, sustainable consumption of resources, reduction of ecological footprints. ● Role of green technology in sustainable future, major challenges and their solutions for the implementation of green technology.	**15**
Unit II: Applications of green technologies	● Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, energy efficient lighting, control	**15**

	and selection of luminaires; biofuels, green manufacturing systems, selection of recyclable and environment friendly materials in manufacturing, design and implementation of sustainable green production systems. ● Pollution reduction and removal (Flue Gas Desulfurization FGD) methods, catalytic or thermal destruction of NO_X, Fluidized Bed Combustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals, solvent recovery systems, Low Volatile Organic Compound (VOC) paints and sealers.	
Unit III: Green chemistry and green infrastructure	● Introduction to green chemistry; principles and recognition of green criteria in chemistry; ● Green nanotechnology; ● Reagents, reactions and technologies that should be and realistically could be replaced by green alternatives; Photodegradable plastic bags ● Concept of green cities, waste reduction and recycling in cities, public transport, green belts ● History of green buildings, need and relevance of green buildings over conventional buildings, outlined examples of green buildings; LEED certified building.	**15**

Practical:

COURSE CODE	**TITLE**	**CREDITS**	**HOURS**
SIUSEVSP46	**GREEN TECHNOLOGY**	**1**	**15**
1. Biosynthesis of nanoparticles and its characterization using UV-visible spectrophotometer. 2. Measurement of solar constant. 3. Identification of petrocrops used in energy plantations. 4. Identification of green belts in urban areas.			

References:

1. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.

2. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press.

3. Khan, B. H. (2006). Non-conventional Energy Resources. India: McGraw-Hill Education (India) Pvt Limited.

4. Sanghi, R. (2003). Green Chemistry: Environment Friendly Alternatives. India: Narosa Publishing House.

5. Bishop, P. L. (2000). Pollution Prevention: Fundamentals and Practice. United Kingdom: McGraw-Hill.

6. N. Vinutha bai, R. Ravindra, Energy efficient and green technology concepts, International Journal of Research in Engineering and Technology p 253-258, Volume: 03 Special Issue: 06, 2014, eISSN: 2319-1163 pISSN: 2321-7308.

SEMESTER IV: ABILITY ENHANCEMENT COURSE II (FC II)

COURSE CODE	TITLE	LECTURES
SIUSEVST47	**COMPUTER APPLICATIONS**	
Course Objective: To impart the basic knowledge of use of computers which has become a mandatory aspect of learning and research today. **Learning Outcome:** The learners will be able to understand the basic software and hardware components of computers and use Microsoft office applications such as Word, Excel, Powerpoint to present their work in an appealing and authentic way.		
Unit-I: Fundamentals of Computers	● Invention and History of computers; Components; Input and Output devices ● Primary and secondary storage devices ● Data representations: files and folders with different file formats; Security and safety of data; ● Operating systems; Internet & its applications; Cloud storage; Softwares for scientific use; Softwares for use in Environmental Science; ● Computer Virus and associated issues.	**15**

Unit II: Introduction to M S Office and M S Word	• Microsoft Office - Desktop; Control panel; Accessories; Managing documents and folders • Microsoft Word – Creating new document; Page Layout; Styles and Themes; Columns and Ordering; Working with Text; Format Text; Text boxes; Listing of Text; Use of various shapes; Pictures and Clip Arts; Use of Tables; SmartArt Graphics; Proofing features and Auto Correct; Hyperlinks; Mail Merge; Cross Reference; Saving documents; Printing of documents.	**15**
Unit III: M S Excel and M S PowerPoint	• **Microsoft Excel –** Starting a workbook; Modifying columns, rows and cells; Formatting cells; Creating Simple formulas and Complex formulas; Error values; Working with cells; Sorting, grouping and filtering cells; Formatting Tables; Aligning Texts; Basic functions in a workbook; Printing a workbook; Working with Worksheets; Freezing worksheet panes; Use of Charts; Conditional Formatting. • **Microsoft PowerPoint –** Uses of PowerPoint presentations; Basics of Presentation slides; Text Basics; Themes and Background styles; Pictures and Clip Art; Viewing and Printing slides; Animating Texts and Objects; Use of Slide Transitions; Slide Master; Hyperlinks and Action buttons; Slide Show options.	**15**

References:

1. Maluth, J. (2016). Basic Computer Knowledge. (n.p.): Amazon Digital Services LLC - Kdp.
2. Wempen, F. (2014). Computing Fundamentals: Introduction to Computers. Germany: Wiley.
3. Thareja, R. (2019). Fundamentals of Computers. India: Oxford University Press.
4. Wong, W., Englander, I. (2021). The Architecture of Computer Hardware, Systems Software, and Networking: An Information Technology Approach. United Kingdom: Wiley.

5. Foulkes, L. (2020). Learn Microsoft Office 2019: A Comprehensive Guide to Getting Started with Word, PowerPoint, Excel, Access, and Outlook. United Kingdom: Packt Publishing.
6. Habraken, J. (2022). Microsoft Office Inside Out (Office 2021 and Microsoft 365). United States: Microsoft Press.

EVALUATION SCHEME

The performance of the learner shall be evaluated into TWO Parts. The learner's performance shall be assessed by Internal Assessment of 40 Marks and Semester End Examination (theory) of 60 Marks for each term. Practical examination will be conducted at the end of each semester for 300 Marks. The allocation of marks for the Internal Assessment and Semester End Examinations are as follows:- Internal Assessment – 40 Marks There will be two internal assessment tests 20 Marks each – one will be centralized and other will be departmental.

Internal Assessment – 40 Marks

There will be two internal assessment tests 20 Marks each – one will be centralized and the other will be departmental.

Sr. No.	**Particulars**	**Marks**
1.	Centralized : Online test (MCQs)	**20**
2.	Departmental : Class test / Assignment / Presentation	**20**
	Total	**40**

Internal Assessment for SIUSENVT37 (FC I) and SIUSENVT47 (FC II) – 40 Marks

Sr. No.	**Particulars**	**Marks**
1.	Internal Assessment test	**20**
2.	Submission / Assignment based on theory	**20**
	Total	**40**

Semester End Examination – 60 Marks

Sr. No.	**Particulars**	**Marks**
	All questions are compulsory Number of questions – 4 (Four) Each question carries 15 Marks	
1.	Q1 – Unit I a. Long Answer type (one out of two)	**10**

	b. Short answers (one out of two)	**5**
2.	Q1 – Unit II a. Long Answer type (one out of two) b. Short answers (one out of two)	 **10** **5**
3.	Q1 – Unit III a. Long Answer type (one out of two) b. Short answers (one out of two)	 **10** **5**
4.	Q4 – Short notes based on Units I, II and III (any three out of five)	**15**
	Total	**60**

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