



College of Arts,
Science &
Commerce (Autonomous)

RISE WITH EDUCATION

NAAC REACCREDITED - 'A' GRADE

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

Syllabus effective from June 2024

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

**SIES COLLEGE OF ARTS, SCIENCE AND COMMERCE (EMPOWERED AUTONOMOUS),
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Semester V

Core Course and Applied Component

Name of Program: B.Sc.		Name of Department: Environmental Science			
Class	Semester	Course Code	Course Name	No. of lectures/ per week	Credits
TYBSc	V	SIUSEVST51	Climate Change	4	2.5
TYBSc	V	SIUSEVST52	Natural Hazards and Disaster Management	4	2.5
TYBSc	V	SIUSEVST53	Sustainable Development	4	2.5
TYBSc	V	SIUSEVST54	Environmental Management Systems	4	2.5
TYBSc	V	SIUSEVSP56	Climate Change, Natural Hazards and Disaster Management Practical	8	3
TYBSc	V	SIUSEVSP57	Sustainable Development, Environment Management Systems Practical	8	3
TYBSc	V	SIUSEVSACT55	Remote Sensing and GIS (Applied Component)	4	2
TYBSc	V	SIUSEVSACP58	Remote Sensing and GIS Practical (Applied Component)	4	2

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Semester VI

Core Course

Name of Program: B.Sc.			Name of Department: Environmental Science		
Class	Semester	Course Code	Course Name	No. of lectures/ per week	Credits
TYBSc	VI	SIUSEVST61	Restoration ecology	4	2.5
TYBSc	VI	SIUSEVST62	Renewable Energy and Environment	4	2.5
TYBSc	VI	SIUSEVST63	Occupational Health and Safety	4	2.5
TYBSc	VI	SIUSEVST64	Environmental Impact Assessment	4	2.5
TYBSc	VI	SIUSEVSP66	Application of Sustainability, Renewable Energy and Environment Practical	8	3
TYBSc	VI	SIUSEVSP67	Occupational Health and Safety, Environmental Impact Assessment Practical + Project work	8	3
TYBSc	VI	SIUSEVSACT65	Environmental Entrepreneurship Development(App lied Component)	4	2
TYBSc	VI	SIUSEVSACP68	Environmental Entrepreneurship Development Practical(Applied Component)	4	2

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<p>Course Name: Climate Change Course Code- SIUSEVST51 Credits: 2.5 Type: Core</p>		
<p>Expected Course Outcomes</p> <p>On completion of this course, students will be able to</p> <ol style="list-style-type: none"> 1. Get a deeper insight into the understanding of climate change and the associated issues. 2. Elucidate the roles of various greenhouse gases in contributing to climate change. 3. Observe and understand the impacts of climate in various sectors. 4. Explore the changing trends in life and lifestyle with respect to changing climatic variations. 5. Appreciate the efforts taken to mitigate the climate change issue and effectively contribute to the same. 		
Unit I	Climate change	
	<ul style="list-style-type: none"> ● Introduction to climate change ● Greenhouse effect, Greenhouse effect potential and associated concerns of greenhouse gases in climate change ● Global warming, El Nino ● Factors responsible for climate change ● Climate change in relation to the changes in patterns of temperature, precipitation and sea level rise 	
Unit II	Impacts of Climate Change	
	<ul style="list-style-type: none"> ● Melting of glaciers ● Sea level rise ● Ocean acidification ● Loss of biodiversity ● Agriculture, Forestry ● Impacts of Climate Change in different parts of India with future predictions 	

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Unit III	Climate Change adaptation, mitigation and resilience	
	<ul style="list-style-type: none"> ● Adaptation to climate change ● Climate change mitigation ● Climate Justice- case studies ● Resilience- technologies and case studies 	
Unit IV	Climate change: International and National policies and frameworks	
	<ul style="list-style-type: none"> ● Earth Summit ● COP- Loss and damage for climate change ● Blue carbon initiative ● NDCs ● NAPCC ● Mission Green and Life ● Adaptation Strategy/ Mitigation Measures 	

References
<ol style="list-style-type: none"> 1. Global Climate Change. (2021). Srivastava, K. K. Netherlands: Elsevier Science. 2. Assessment of Climate Change Over the Indian Region: A Report of the Ministry of Earth Sciences (MoES), Government of India. (2020). Germany: Springer Open. 3. Romm, J. J. (2018). Climate Change: What Everyone Needs to Know. United States: Oxford University Press. 4. Hall, N. (2016). Displacement, Development, and Climate Change: International Organizations Moving Beyond Their Mandates. United Kingdom: Taylor & Francis. 5. Fletcher, C. H., Fletcher, C. (2018). Climate Change: What The Science Tells Us. United Kingdom: Wiley. 6. Loss and Damage from Climate Change: Concepts, Methods and Policy Options. (2018). Germany: Springer International Publishing. 7. Hulme, M. (2021). Climate Change. United Kingdom: Taylor & Francis.

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Course Name: Natural Hazards and Disaster Management
Course Code- SIUSEVST52
Credits: 2.5 Type: Core

Expected Course Outcomes

On completion of this course, students will be able to

6. Elucidate the factors associated with different types of natural hazards.
7. Understand the causes and potential impacts of various natural hazards.
8. Decipher the vulnerability and risks of different natural hazards in various regions.
9. Empower themselves with management skills associated with various types of disasters in order to handle any potential risk situation.

Unit I	Earth and Atmospheric processes, Natural Hazards and National Disaster Management	
	<ul style="list-style-type: none"> ● Earth and atmospheric process: basics of plate-tectonic, hydro-geomorphic and atmospheric (energy atmospheric circulation) processes. ● Types of Natural Hazards. ● Natural hazards, risk, vulnerability; Hazards and risk assessment. ● National Disaster management framework, National response mechanism, Role of Government bodies such as NDMC, IMD. 	
Unit II	Earthquakes, Tsunami, Volcanoes	
	<ul style="list-style-type: none"> ● Earthquakes - Origin; Seismic waves; Associated hazards, Earthquake prone regions; Damage caused; Responses and Disaster management strategies; Case study. ● Tsunami - Origin; Relation to earthquakes; Impacts; Disaster management strategies; Case study. ● Volcanoes - Causes; Impacts; Disaster management strategies; Active volcanoes in the world; Case study. 	

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Unit III	Droughts and Floods	
	<ul style="list-style-type: none"> ● Drought: Causes and Impacts; Types of droughts (meteorological, hydrological, agricultural and socio-economic); Response to hazards- mitigation and adaptation; Drought status in India; Case study. ● Floods: Floods as physical processes (river systems, runoff, river activities); Causes and factors of flooding, Impacts of flooding; Response to flood hazards; Global and Indian scenario; Case study. 	
Unit IV	Cyclones and Landslides	
	<ul style="list-style-type: none"> ● Cyclones: Genesis; Tropical cyclones - formation, frequency and trajectory; Impacts of cyclones; Mitigation and Adaptation; Management strategies; Cyclones in Indian coasts; Case study. ● Landslides: Genesis (slope failure mechanism); Causes of landslides; Prevention and correction methods; Global and Indian scenario; Case study. 	

References
8. Encyclopedia of Natural Hazards. (2013). Bobrowsky, P. Germany: Springer Netherlands.
9. Keller, E. A., DeVecchio, D. E. (2016). Natural Hazards: Earth's Processes as Hazards, Disasters, and Catastrophes. United Kingdom: Taylor & Francis.
10. Blaikie, P., Cannon, T., Davis, I., Wisner, B. (2014). At Risk: Natural Hazards, People's Vulnerability and Disasters. United Kingdom: Taylor & Francis.
11. Lukasiewickz, A. (2020) Natural Hazards and Disaster Justice: Challenges for Australia and Its Neighbours. Germany: Springer Nature Singapore.
12. Rivera, F. (2019) Emerging Voices in Natural Hazards Research.. United Kingdom: Elsevier Science.
13. Arora, P. (2013) Disaster Management: Medical Preparedness, Response and Homeland Security. United Kingdom: CABI.

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Course Name: Sustainable Development Course Code- SIUSEVST53 Credits: 2.5 Type: Core		
Expected Course Outcomes On completion of this course, students will be able to		
1. Realise the scope, importance, and opportunities for sustainability. 2. Analyse and formulate future goals of sustainability. 3. Have an understanding of the challenges and needs of sustainability.		
Unit I	Understanding Sustainable Development	
	<ul style="list-style-type: none"> ● Definition, origin of sustainable development ● Dimensions and Domains of sustainability ● Concept of ecological footprints and carrying capacity ● Our common future report ● Agenda 21, Sustainable Development Goals and Millennium Development Goals 	
Unit II	Challenges of Sustainable development	
	<ul style="list-style-type: none"> ● Linkages among Sustainable development, environment and poverty ● Education and Sustainable development ● Determinants of sustainable development ● Case studies 	
Unit III	Sustainability and cleaner production	
	<ul style="list-style-type: none"> ● Principles of sustainable development ● Concept of clean production ● Characteristics of cleaner production ● Clean process and clean products 	
Unit IV	International cooperation for sustainability	

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	<ul style="list-style-type: none"> ● World summit on sustainable development ● Role of NGOs and social entrepreneurs ● Cooperation between regions ● People’s Earth Charter
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References	
	<ol style="list-style-type: none"> 1. Rogers, P. P., Jalal, K. F., Boyd, J. A. (2012). An Introduction to Sustainable Development. United Kingdom: Earthscan. 2. Our Common Future, Chapter 2: Towards Sustainable Development: Report of the World Commission on Environment and Development. 3. 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. 4. Environment and Sustainable Development. (2013). India: Springer India. 5. Dr. Mishra A, Dr.Dahiya V., Dr.Tandon K, JSR Publishing House LLP; (2019) Sustainable Development in the Digital Era. 6. Jeffrey D. Sachs and Ban Ki-moon, Columbia University Press (2015) The Age of Sustainable Development. 7. Kalam APJ, Singh, Penguin India (2011). Target 3 Billion: Innovative Solutions Towards Sustainable Development

Course Name: Environmental Management Systems Course Code- SIUSEVST54 Credits: 2.5 Type: Core	
Expected Course Outcomes	
On completion of this course, students will be able to:	
<ol style="list-style-type: none"> 1. Gain knowledge on guidelines of the environmental management system. 2. Acquire the basic understanding of the audit processes. 3. Understand the present scenario of development and environment. 4. Analyse impact on environment through the cost benefit ratio. 	
Unit I	Introduction to Environment Management
	<ul style="list-style-type: none"> ● Concept and definition of Environment Management ● Features and phases of environmental management ● Components and scope of environmental management

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	<ul style="list-style-type: none"> ● Projecting EMS: planning, implementation, general requirements, control tasks ● Development and environmental linkages 	
Unit II	EIA and Environmental Audit	
	<ul style="list-style-type: none"> ● Definition and concept of EIA ● Aims and objectives in EIA ● Stages in EIA ● Introduction to environmental audit ● Features and Objectives of environmental audit ● Environmental audit process ● Types of environmental audit 	
Unit III	ISO and LCA in EMS	
	<ul style="list-style-type: none"> ● Concept of International organisation for Standardisation ● EMS Certification ● ISO 14000 series, principles and methodology ● ISO 16000, ISO 45000, ISO 50000 ● LCA - Evolution, cradle to grave approach, procedure, application of LCA 	
Unit IV	Concept of Carbon Credits and Eco Innovations	
	<ul style="list-style-type: none"> ● Kyoto protocol ● CDM ● Carbon credits and carbon bank ● Concept of eco-innovation ● Preparation, Strategy, Business model, Implementation and review ● Eco-designs ● Environmental cost and benefits 	

References
<p>1..Camborne D F, 1997 Environmental Life Cycle Analysis, Lewis Publishers 2. Jadhav H.V. Environmental management, Vipul Prakashan, Mumbai</p>

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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. Ciambrone, D. F. (1997). Environmental life cycle analysis. CRC Press.
7. Klöpffer, W., & Grahl, B. (2014). Life cycle assessment (LCA): a guide to best practice. John Wiley & Sons.
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. Krishna, I. M., Manickam, V. (2017). Environmental Management: Science and Engineering for Industry. India: Elsevier Science.

Course Name: Climate Change, Natural Hazards and Disaster Management Practical
Course Code: SIUSEVSP56
Credits: 3

Expected Course Outcomes

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

1. Compare the carbon sequestration potential of different tree species and can suggest suitable species for reforestation programs.
2. Estimate the carbon footprint values for different individuals and sectors and suggest suitable measures to reduce the footprints.
3. Understand the causes and consequences of various natural hazards.
4. Study the disaster management methods against different natural hazards.

Practical No.	Title
1.	Determination of Carbon Sequestration potential of different tree species.
2.	Calculation of carbon footprint - report preparation.
3.	Case study of natural hazards and disaster management - report preparation.

References

14. Ussiri, D. A. N., Lal, R. (2017). Carbon Sequestration for Climate Change Mitigation and Adaptation. Germany: Springer International Publishing.
15. Colson, A. M. (2015). Reduce Your Carbon Footprint: A Beginners Guide to Reducing Your Greenhouse Gas Emissions. United States: CreateSpace Independent Publishing Platform.
16. Heating With Wood: Producing, Harvesting and Processing Firewood,” Scott DeWald, Scott Josiah, and Becky Erdkamp, University of Nebraska – Lincoln Extension, Institute of Agriculture and Natural Resources, March 2005.

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17. Carbon Storage and Accumulation in United States Forest Ecosystems, General Technical Report W059," Richard A. Birdsey, United States Department of Agriculture Forest Service, Northeastern Forest Experiment Station, Radnor, PA, August 1992.
18. Total-Tree Weight, Stem Weight, and Volume Tables for Hardwood Species in the Southeast," Alexander Clark III, Joseph R. Saucier, and W. Henry McNab, Research Division, Georgia Forestry Commission, January 1986.
19. <https://www.lifestylecalculator.com/unfccc>

Course Name: Sustainable Development and Environmental Management Systems Practical
Course Code: SIUSEVSP67
Credits: 3

Expected Course Outcomes

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

1. Increase their understanding of sustainability.
2. Understand challenges associated with sustainable development.
3. Analyse and summarise the reports on LCA, EIA.

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

References

1. 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.
2. Kalam APJ, Singh, Penguin India (2011). Target 3 Billion: Innovative Solutions Towards Sustainable Development
3. Guinée, J. B., & Lindeijer, E. (Eds.). (2002). Handbook on life cycle assessment: operational guide to the ISO standards (Vol. 7). Springer Science & Business Media.
4. Ciambrone, D. F. (1997). Environmental life cycle analysis. CRC Press.
5. Klöpffer, W., & Grahl, B. (2014). Life cycle assessment (LCA): a guide to best practice. John Wiley & Sons.
6. Jackson, S. L. (1997). The ISO 14001 implementation guide: creating an integrated management system (Vol. 3). John Wiley & Sons.

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<p>Course Name: Remote Sensing and GIS Course Code: SIUSEVSACT55 Credits: 2 Type: Applied Component</p>		
<p>Expected Course Outcomes</p> <p>On completion of this course, students will:</p> <ol style="list-style-type: none"> 1. Get acquainted with the use of the latest technology for environmental issues. 2. Be enlightened with the use of satellites, images and their processing to observe the environment in any part of the world. 3. Analyse and process digitally obtained photographs and images of various parts of the Earth. 4. Apply the knowledge of satellite technology in understanding ecosystems and resolving global environmental problems. 		
Unit I	Introduction to Concepts and Systems in Remote Sensing	
	<ul style="list-style-type: none"> ● Electromagnetic Energy and Electromagnetic Spectrum ● Image Characteristics ● Remote Sensing Systems ● Imaging and Scanning Systems ● Sources of Remote Sensing Information 	
Unit II	Satellite Imagery and Digital Image Processing	
	<ul style="list-style-type: none"> ● Remote Sensing Satellites, Environmental Satellites. ● Types of Photographs - Aerial, Black-and-White, Color Photographs, Photographs from Satellites. ● Structure of Digital Images. ● Digital Image Processing, Restoration, Enhancement. ● Hardwares and Softwares for Image Processing. 	
Unit III	Meteorologic, Oceanographic and Environmental Applications	
	<ul style="list-style-type: none"> ● UV Radiation and Ozone Concentration. ● Climate and Weather studies. ● Ocean Productivity and Ocean Currents. ● Sea Ice. 	

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	<ul style="list-style-type: none"> • Environmental Pollution studies. 	
Unit IV	Land Use, Land Cover and Natural Hazards using GIS	
	<ul style="list-style-type: none"> • Classification of Land Use and Land Cover. • Geographic Information Systems. • Vegetation Mapping. • Role of Remote Sensing and GIS in studying Natural Hazards - Earthquakes, Landslides, Volcanoes, Floods, Forest fires. 	

References
<ol style="list-style-type: none"> 1. F. S. Floyd, M. E. James. (2020). Remote Sensing: Principles, Interpretation, and Applications, Fourth Edition. (n.p.): Waveland Press. 2. Borengasser, M., Hungate, W. S., Watkins, R. (2007). Hyperspectral Remote Sensing: Principles and Applications. United States: Taylor & Francis. 3. Ryerson, R. A. (1998). Manual of Remote Sensing: Principles and applications of imaging radar. United Kingdom: J. Wiley. 4. G., Chandra (2016). Remote Sensing of Land Use and Land Cover: Principles and Applications. United States: CRC Press. 5. Panda, B. C. (2005). Remote Sensing: Principles and Applications. India: Viva Books Private. 6. Patel, A. N. (2007). Remote Sensing : Principles And Applications (2Ed.). India: Scientific Publishers.

Course Name: Remote Sensing and GIS Practical Course Code: SIUSEVSACP58 Credits: 2 Type: Applied Component	
Expected Course Outcomes	
On completion of this course, students will be able to: <ol style="list-style-type: none"> 1. Interpret satellite images of different locations based on colours and textures. 2. Map a plant community using a GPS system and determine the respective coordinates. 3. Explore softwares such as Google Earth and capture images of different ecosystems. 4. Enhance the use of the latest technologies and softwares in ecological studies. 	
Practical No.	Title
1.	Interpretation of satellite imagery using various colour codes.
2.	Vegetation mapping using Garmin's GPS instrument.

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3.	Images of locations with different topographies using Google Earth.
4.	Case studies of use of remote sensing for studying and comparing different ecosystems on earth.

References	
20.	Ünsalan, C., Boyer, K. L. (2011). Multispectral Satellite Image Understanding: From Land Classification to Building and Road Detection. Netherlands: Springer London.
21.	Google Earth and Virtual Visualizations in Geoscience Education and Research. (2012). United States: Geological Society of America.
22.	Remote Sensing of Forest Environments: Concepts and Case Studies. (2012). United States: Springer US.

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Semester VI

Core Course and Applied Component

Name of Program: B.Sc.			Name of Department: Environmental Science		
Class	Semester	Course Code	Course Name	No. of lectures/ per week	Credits
TYBSc	VI	SIUSEVST61	Restoration ecology	4	2.5
TYBSc	VI	SIUSEVST62	Renewable Energy and Environment	4	2.5
TYBSc	VI	SIUSEVST63	Occupational Health and Safety	4	2.5
TYBSc	VI	SIUSEVST64	Environmental Impact Assessment	4	2.5
TYBSc	VI	SIUSEVSP66	Application of Sustainability, Renewable Energy and Environment Practical	8	3
TYBSc	VI	SIUSEVSP67	Occupational Health and Safety, Environmental Impact Assessment Practical + Project work	8	3
TYBSc	VI	SIUSEVSACT65	Environmental Entrepreneurship Development(Appli ed Component)	4	2
TYBSc	VI	SIUSEVSACP68	Environmental Entrepreneurship Development Practical (Applied Component)	4	2

Semester VI

<p>Course Name: Restoration Ecology Course Code: SIUSEVST61 Credits: 2.5 Type: Core</p>	
<p>Expected Course Outcomes</p> <p>On completion of this course, students will be able to</p> <ul style="list-style-type: none"> ● Articulate the concept of restoration and historical development. ● Describe the major ecological principles of restoration. ● Understand metropolitan ecological restoration concepts. ● Apply appropriate methods and tools for designing and conducting restoration projects. 	
Unit I	Introduction to Restoration
	<ul style="list-style-type: none"> ● History of Eco Restoration ● Definition, Principles of Restoration ● Significances ● Strategies and Guidelines of Ecological Restoration ● Restoration Plan and Rehabilitation Measures ● Linking Restoration with Human well being and services ● Understanding Limitations i) Biological Limitations ii) Physical Limitations iii) Chemical Limitations
Unit II	Forest Restoration
	<ul style="list-style-type: none"> ● Degraded forest patches ● Wetland and Mangroves restoration ● Grasslands restoration ● Plant and Animal Reintroduction, Mangrove Rehabilitation ● Greenness improvement, planting technologies, bamboo forest ● Overcoming Limitations: Revegetation, Mulching, Phytoremediation ● Cases studies
Unit III	Freshwater Restoration

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	<ul style="list-style-type: none"> ● 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; ● Water harvesting in streams: Biological measures, check dam, gully plug, Gabion structure, Overflow weir, earthen dam, Underground bandhara. ● Soil and water conservation aspects: contour trenches, continuous contour benches, live hedges, infiltration pit, in situ conservation through appropriate cultivation practices ● Ground water resource – replenishment ● Case studies
Unit IV	Restoration of Urban Ecosystem
	<ul style="list-style-type: none"> ● Biodiversity restoration through gardens, park, avenue trees ● Restoration of dumping grounds ● Restoration of soil in urban areas ● Restoration of ecosystem on hills ● Coastal Restoration, land reclamation ● Sewage or wastewater – recycling for supporting ecosystems ● Overcoming Limitations: Collaborative Restoration ● Case studies

References
<ol style="list-style-type: none"> 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

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Course Name: Renewable Energy and Environment
Course Code: SIUSEVST62
Credits: 2.5 Type: Core

Expected Course Outcomes

On completion of this course, students will be able to

- Acquaint themselves with the ongoing energy crisis.
- Explore the potentials of using different types of renewable energy sources.
- Illustrate the construction and working of different power plants working on renewable energy.
- Understand the environmental impacts and safety issues associated with the use of renewable energy sources.

Unit I	Introduction to Renewable Energy
	<ul style="list-style-type: none"> ● Energy requirements and growing demands in various sectors ● Sources of energy ● Meaning and definition of Renewable energy ● Principles of renewable energy ● SWOT analysis of renewable energy ● Technical Implications of renewable energy ● Energy storage and distribution ● Comparison of renewable and conventional sources of energy ● World Energy transformation by 2050
Unit II	Solar Energy and Wind Energy
	<p>Solar Energy -</p> <ul style="list-style-type: none"> ● Solar Radiation, Solar cells and Solar panels ● Devices using solar energy - solar cooker, solar water heater, other electronic appliances ● National Solar Mission in India ● Solar power plants ● Significance and challenges of using solar power <p>Wind Energy -</p> <ul style="list-style-type: none"> ● Wind Energy potential

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	<ul style="list-style-type: none"> ● Windmills - Construction and working ● Wind Energy farms ● Environmental effects of using wind power
Unit III	Energy from Water and Nuclear Energy
	<p>Energy from Water -</p> <ul style="list-style-type: none"> ● Potential of obtaining energy from water ● Hydroelectric power plants - Construction and working ● Environmental impacts of dam constructions ● Energy from tides, oceans and waves <p>Nuclear Energy -</p> <ul style="list-style-type: none"> ● Principle of nuclear fission and nuclear energy ● Nuclear power plants - Construction and working ● Advantages and disadvantages of using nuclear energy ● Environmental safety issues of using nuclear energy
Unit IV	Geothermal Energy and Bioenergy
	<p>Geothermal Energy -</p> <ul style="list-style-type: none"> ● Principle and Potential as energy source ● Types of geothermal energy ● Geothermal power plants - Construction and Working ● Geothermal sites in India ● Environmental significance <p>Bioenergy -</p> <ul style="list-style-type: none"> ● Meaning and concept ● Biomass, Biofuels Petrocrops ● Emerging trends and Case studies of biofuels ● Environmental significance of bioenergy

References
1. Twidell, J., Weir, T. (2006). Renewable Energy Resources. United Kingdom: Taylor & Francis.

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2. Ghosh, T. K., Prelas, M. A. (2011). Energy Resources and Systems: Volume 2: Renewable Resources. Germany: Springer Netherlands.
3. Kamran, M., Fazal, M. R. (2021). Renewable Energy Conversion Systems. United Kingdom: Elsevier Science.
4. Salameh, Z. (2014). Renewable Energy System Design. United States: Elsevier Science.
5. Moorman, C. E., Grodsky, S. M., Rupp, S. (2019). Renewable Energy and Wildlife Conservation. United States: Johns Hopkins University Press.
6. Renewable Energy: Sources, Applications and Emerging Technologies. (2016). United States: Nova Science Publishers, Incorporated.
7. Rathore, N. S., Panwar, N. L. (2007). Renewable Energy Sources for Sustainable Development. India: New India Publishing Agency.

Course Name: Occupational Health and Safety
Course Code: SIUSEVST63
Credits: 2.5 Type: Core

Expected Course Outcomes

On completion of this course, students will be able to

- Learn the basics of Occupational Health Hazards.
- Learn the common occupational diseases.
- Get acquainted with the principles of ergonomics.
- Familiarise with Process Safety Management (PSM) as per OSHA.

Unit I	Introduction to Occupational hazard
	<ul style="list-style-type: none"> ● Definition of Occupational Health as per WHO/ILO. ● Occupational Health and Environmental Safety Management - Principles & practices. ● Common Occupational diseases: Occupational Health Management Services at the workplace. Pre-employment, periodic medical examination of workers, medical surveillance for control of occupational diseases and health records.
Unit II	Monitoring for Safety, Health and Environment
	<ul style="list-style-type: none"> ● Occupational Health and Environment Safety Management System, ILO and EPA Standards.

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	<ul style="list-style-type: none"> ● Industrial Hygiene: Definition of Industrial Hygiene, Industrial Hygiene: Control Methods, Substitution, Changing the process, Local Exhaust Ventilation, Isolation, Wet method, Personal hygiene, housekeeping and maintenance, waste disposal, special control measures. ● Chemical Hazard: Introduction to chemical hazards, dangerous properties of chemical, dust, gases, fumes, mist, Vapours, Smoke and aerosols. Route of entry to human system, recognition, evaluation and control of basic hazards, concepts of dose response relationship, biochemical action of toxic substances. Concept of threshold, limit values.
Unit III	Occupational Health and Environmental Safety Education
	<ul style="list-style-type: none"> ● Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies. Evaluation and review of training programs. ● Occupational Health Hazards, Promoting Safety, Safety and Health training, Stress and Safety, Exposure Limit ● Ergonomics-Introduction, Definition, Objectives, Advantages. Ergonomics Hazards. Musculoskeletal Disorders and Cumulative Trauma Disorders. Physiology of respiration, cardiac cycle, muscle contraction, nerve conduction system etc. Assessment of Workload based on Human physiological reactions. Permissible limits of load for manual Lifting and carrying. Criteria or fixation limits.
Unit IV	Occupational Safety, Health and Environment Management
	<ul style="list-style-type: none"> ● Bureau of Indian standards on safety and health 14489 - 1998 and 15001 – 2000, OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM. ● Importance of Industrial safety, role of safety department, Safety committee and function, Role and responsibilities of safety officer ● Sources of information on Safety, Health and Environment Protection. Compilation and collation of information, Analysis and use of modern

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	<p>methods of programming, storing and retrieval of MIS for Safety, Health and Environment.</p> <ul style="list-style-type: none"> • SQA Computer Software Application and Limitations. iii. Status and future goals of computer utilization in Safety, Health and Environment (SHE) Services in Industries
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References	
	<ol style="list-style-type: none"> 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.

<p>Course Name: Environmental Impact Assessment Course Code: SIUSEVST64 Credits: 2.5 Type: Core</p>

Expected Course Outcomes	
<p>On completion of this course, students will be able to</p> <ul style="list-style-type: none"> • Acquire the basic understanding of the environmental impact. • Realise the scope and need of EIA. • Understand the present scenario of development and environment. • Gain knowledge on guidelines of the environmental impact assessment. • Analyse impact on environment through the cost benefit ratio. • Have an understanding of the challenges and benefit of environmental management tool. • Comprehend the EIA process for various developmental projects. 	

Unit I	Environmental Impacts
	<ul style="list-style-type: none"> • Environmental Attributes • Nature of Impacts- Primary, Secondary, and Tertiary

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	<ul style="list-style-type: none"> ● Short Term, Long Term, Reversible and Irreversible Impacts. ● Overview of Impacts- Directly and Indirectly Measurable Impacts of Air, Noise, Water, Land, Biological and Socio-Economic Elements
Unit II	Environmental Impact Assessment
	<ul style="list-style-type: none"> ● Definition ● Introduction and concepts ● Rationale and historical development of EIA ● Need for EIA ● Stages of EIA ● Scope and methodologies of EIA- Checklist, Matrices and Networks, Cost Benefit Analysis ● Environmental appraisal of projects
Unit III	Environment Management Plan (EMP)
	<ul style="list-style-type: none"> ● Role of project proponents, project developers and consultants, Terms of Reference ● Impact identification and prediction ● Baseline data collection ● Environmental Impact Statement (EIS) ● Environmental Management Plan (EMP) ● Strategies for Environmental Management Plan and Green Belt Development ● Benefits of EIA
Unit IV	EIA regulations
	<ul style="list-style-type: none"> ● EIA regulations and notification in India ● Status of EIA in India ● Rapid EIA ● Strategic Environmental Assessment ● Social Impact Assessment ● Current issues in EIA

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	<ul style="list-style-type: none"> ● Role of Agencies in EIA clearance ● Case study of hydropower projects, thermal projects, Metro projects, Airport projects in India
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References	
	<ol style="list-style-type: none"> 1. Environmental Impact Assessment: Principles and Procedures, John Wiley and Sons, New York. 2. Environmental Impact Assessment: A.K.Shrivastav, APH Publishing Corporation, New Delhi. 3. Environmental Impact Assessment: S.A.Abbasi, D.S.Arya, Discovery Publishing House, New Delhi. 4. Environment Problems and Solutions: D.K.Asthana and Meera Asthana, S.Chand & Co. Ltd. New Delhi. 5. An Introduction to Environmental Management: Dr.Anand S.Bal. 6. John G. Rau and David C Wooten 1980, Environmental Impact Analysis Handbook. Mcgraw- Hill. 7. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA. 8. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.

Course Name: Restoration ecology & Renewable Energy in Environment Practical Course Code: SIUSEVSP66 Credits: 3	
Expected Course Outcomes	
On completion of this course, students will be able to	
<ul style="list-style-type: none"> ● Locate the watershed areas and understand features. ● Articulate the state of eco restored and reclaimed areas. ● Understand the ecological significance of using vegetable oil to prepare biodiesel. 	
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.	Construction, working and principle of a solar cooker.
5.	Preparation of crude biodiesel from virgin vegetable oil.

References
<ol style="list-style-type: none">1. Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series), Donald A. Falk, Margaret Palmer, Joy Zedler, Richard J2. Soil and water conservation engineering by R. Suresh – Standard Publishers and Distributors ISBN 81801400083. Van Gerpen, J., B. Shanks, R. Pruszko, D. Clements, and G. Knothe. 2004. Biodiesel production technology. National Renewable Energy Laboratory. Golden, CO.4. Hill, J., E. Nelson, D. Tilman, S. Polasky, and D. Tiffany. Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels. PNSS. 103(30): 11206-11210. 2006.

<p>Course Name: Occupational Health and Safety, Environmental Impact Assessment Practical and Project work Course Code: SIUSEVSP67 Credits: 3</p>

<p>Expected Course Outcomes</p> <p>On completion of this course, students will be able to</p> <ul style="list-style-type: none">● Apply the scientific standards in different aspects of workplace safety.● Implement "safe" systems- procedures or methods to be applied in the workplace or to the environment.● Learn various guidelines for the Environmental management system.

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.	Survey of occupational diseases across various sectors through questionnaire method and report preparation.
4.	Conducting mock drills with respect to occupational hazards and safety.
5.	Summary report of EIA of any developmental project.

References

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1. Handbook of Occupational Safety and Health. (1976). United States: National Safety Council.
2. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.
3. John G. Rau and David C Wooten 1980, Environmental Impact Analysis Handbook. McGraw- Hill.

Course Name: Environmental Entrepreneurship Development
Course Code: SIUSEVSACT65
Credits: 2 Type: Applied Component

Expected 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.
- Understand the regulatory landscape and legal considerations relevant to environmental entrepreneurship.
- Conduct market analysis and customer research to identify target markets.
- Develop effective communication skills to pitch business ideas to potential investors.

Unit I	Ecopreneurship
	<ul style="list-style-type: none"> ● Introduction to Ecopreneurship ● Critical global challenges ● Eco-efficient and eco-effective design, products and services, eco-industrial design and development ● Strategy for a new green business, Positioning, Pitching ● Writing a business plan ● Sustainable business models
Unit II	Policy and regulations
	<ul style="list-style-type: none"> ● Concept of entrepreneur ● Entrepreneurship Development ● Characteristics of entrepreneurs; SWOT Analysis & achievement motivation

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	<ul style="list-style-type: none"> ● Government policy and programs & institutions for entrepreneurship development
Unit III	Marketing and Business Development
	<ul style="list-style-type: none"> ● 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 IV	IPR
	<ul style="list-style-type: none"> ● Different property rights & IPR in India ● TRIPS & Patent laws: Introduction & standards for patent protection ● WTO & Indian Patent Laws ● Copyrights, trademarks, Geographical Indication (GI) tags ● Protection of traditional knowledge – Objective, concept of traditional knowledge, holders, issue concerning, bioprospecting and biopiracy; Advantages of IPR , some case studies ● International Depository Authority, Gene patenting, Plant variety protection, Trade secrets & Plant breeders’ right ● Accreditation of Environmental consultancies, standards and certification

References
<ol style="list-style-type: none"> 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.
Online Resources
<ol style="list-style-type: none"> 1. https://www.agricorn.in/2023/03/entrepreneurship-development-and-business-communication-unit-1.html 2. https://nbs.net/five-principles-of-a-sustainable-business-model/

Course Name: Environmental Entrepreneurship Development Practical Course Code: SIUSEVSACP68 Credits: 2 Type: Applied Component	
Expected Course Outcomes	
On completion of this course, students will be able to	
<ul style="list-style-type: none">● 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.	Survey of any entrepreneur through questionnaire method and report preparation.
3.	Drafting a provisional patent application.
4.	Case studies of Environmental Entrepreneurship.

References	
<ol style="list-style-type: none">1. Bouchoux, D. E. (2012). Intellectual Property: The Law of Trademarks, Copyrights, Patents, and Trade Secrets. United States: Delmar Cengage Learning.2. Biodiversity, Biotechnology and Traditional Knowledge: Understanding Intellectual Property Rights. (2010). India: Narosa Publishing House.	
Online Resources	
<ol style="list-style-type: none">1. https://cmox.co/business-development-vs-marketing/2. https://onlinecourses.nptel.ac.in/noc23_mg61/preview	