

<b>Course Title:</b> Water and Soil Pollution				
<b>Course code:</b> UES 206	<b>No. of credits:</b> 4	<b>L-T-P:</b> 40-20-0	<b>Learning hours:</b> 60	
<b>Pre-requisite course code and title (if any):</b> No				
<b>Department:</b> Natural and Applied Sciences				
<b>Course coordinator:</b>		<b>Course instructor:</b>		
<b>Contact details:</b>				
<b>Course type:</b> Major		<b>Course offered in:</b> Semester 4		
<b>Course Description</b> This course covers the fundamental principles of water and soil pollution, focusing on the sources, types, and impacts of various pollutants. Students will explore the mechanisms of pollution transport and fate within the environment, the effects of pollution on ecosystems, pollution monitoring and assessment. The course also addresses pollution prevention, control, and remediation strategies, providing a comprehensive understanding of how to manage and mitigate the impacts of pollution on water and soil resources.				
<b>Course objectives</b> The course aims to build the following basic understanding among students: <ul style="list-style-type: none"> <li>• various sources of water and soil pollution and classification of pollutants</li> <li>• interpretation of pollutant movement through water and soil environments</li> <li>• knowledge of sampling methods, bioindicators, analytical techniques for detecting and quantifying contaminants in water and soil</li> <li>• familiarity with the strategies for mitigating pollution, including water treatment technologies, soil remediation methods and best management practices</li> </ul>				
<b>Course content</b>				
<b>Module</b>	<b>Topic</b>	<b>L</b>	<b>T</b>	<b>P</b>
1	<b>Introduction to water and soil pollution</b>			
	This module introduces key concepts of pollution in water and soil, including definitions, types, sources, and the environmental impacts of pollutants.  Global water distribution; sources of water and soil pollution; historical context and major soil and water pollution events. Types of soil pollutants: physical, chemical, and biological; mining related soil pollution: mine overburden, mine tailing acidity. Types/class of water; water quality parameters; sewage pollution; industrial pollution; thermal pollution; marine pollution; agricultural pollution; urban runoff and storm water pollution leading to eutrophication process.	12	2	
2	<b>Transport, fate, monitoring, and assessment of water pollution</b>			
	This module covers the movement and degradation of water pollutants in subsurface flow and groundwater introducing models like Darcy's Law, and techniques for analysing pollutants.  Darcy's Law; processes governing pollutant transport; factors influencing pollutant behaviour; residence time; biological and temperature stratification; lake turn over; N/P cycles; fate of pollutants in water bodies; POPs and PBTs; monitoring techniques for analysing pollutants.	8	2	
3	<b>Transport, distribution, and deposition of soil pollutants</b>			
	Students learn about the mechanisms of pollutant transport in soil and the retention of pollutants in different soil types, emphasizing how different factors influence pollutant behaviour and environmental risk.  Pollutant transport in soil; retention of pollutants in different soil types; mobility,	8	2	

	bioavailability, and toxicity of different soil contaminants; metal cycles (Hg/As/Cr); degradation of organic pollutants such as pesticides and POPs.			
4	<b>Pollution prevention, control, and remediation strategies</b>			
	This module covers strategies for pollution prevention and remediation of water and soil, and relevant laws and policies.  Water and soil quality standards and guidelines; role of laws, policies, and international treaties in pollution control and prevention; best management practices in agriculture, industry, and urban planning; water treatment technologies; soil remediation methods including physical chemical and biological methods; role of remote sensing techniques and sensors in tracking the pollutant distribution and exploring remediation techniques for water and soil pollution.	12	2	
5	<b>Case studies of water and soil pollution</b>			
	Students will explore different case studies focussing on interconnected challenges of water and soil pollution, emerging contaminants, health impacts, and sustainable solutions.  Case studies and visit to nearby polluted sites and urban soil pollution hot spots for understanding interlinkages of water and soil pollution, impact of renewable energy on water and soil conservation, wastewater and fecal sludge pollution and health impacts, emerging contaminants like microplastics and pharmaceuticals.		12	
	<b>Total</b>	40	20	
<b>Evaluation criteria</b>				
<ul style="list-style-type: none"> <li>• Minor Test I: Written test [at the end of teaching of modules 1, 2] -- 20%</li> <li>• Minor Test II: Written test [at the end of teaching of modules 3, 4] -- 20%</li> <li>• Major Test: Written test [at the end of the semester, full syllabus] -- 40%</li> <li>• Assignments/Presentations on case studies: 20%</li> </ul>				
<b>Learning outcomes</b>				
<p>Upon completion of the course, the students will be able to</p> <ul style="list-style-type: none"> <li>• understand the key concepts: learn the key concepts, definitions, and terminology related to water and soil pollution and identify various sources and types of water and soil pollutants [Minor Test I and Major Test].</li> <li>• gain analysis and investigation skills: learn analytical methods for assessing the quality of water and soil, determine the transport and fate of pollutants in water and soil environments [Minor Test I, Minor Test II and Major Test].</li> <li>• evaluate and assess: critically assess the effectiveness of various pollution monitoring and assessment techniques, evaluate existing pollution prevention and remediation strategies, considering their environmental sustainability and effectiveness [Minor Test II and Major Test].</li> <li>• develop critical thinking and problem-solving skills: propose innovative solutions for mitigating water and soil pollution, integrating knowledge from various disciplines and design comprehensive management plans that address pollution sources, impacts, and prevention measures [Assignments/Presentations].</li> </ul>				
<b>Pedagogical approach</b>				
<ul style="list-style-type: none"> <li>• The course will be delivered through lectures, tutorials, and discussion of case studies.</li> </ul>				
<b>Reading materials</b>				
<ul style="list-style-type: none"> <li>• Pani, B. (2018). <i>Textbook of Environmental Chemistry</i>. (2nd ed.). I.K. International Publishing House Pvt. Ltd.</li> <li>• Manahan, S.E. (2010). <i>Fundamentals of Environmental Chemistry</i>. (9th ed.). Taylor &amp; Francis.</li> <li>• Mirsal, I.A. (2008). <i>Soil pollution. Origin, Monitoring and Remediation</i>. (2nd ed.). Springer.</li> <li>• Brady, N.C. &amp; Weil, R.R. (2002). <i>The Nature and Properties of Soils</i>. (13th ed.). Prentice Hall.</li> </ul>				
<b>Journals</b>				

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| <ul style="list-style-type: none"><li>• Chemosphere</li><li>• Journal of Environmental Management</li><li>• Water Research</li><li>• Science of The Total Environment</li></ul> |
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**Student Responsibilities**

The students must attend the classes regularly and ensure timely submissions of tutorials and assignments. Their other responsibilities include feedback and discipline in the class.

**Course Designed by:**

- Dr. Saumya Arya, Assistant Professor, Department of Natural and Applied Sciences, TERI School of Advanced Studies
- Dr. Ranjana Ray Chaudhuri, Associate Professor, Department of Natural and Applied Sciences, TERI School of Advanced Studies

**Course Reviewers:**

The course is reviewed by following reviewers:

- Dr. Sudesh Yadav, Professor, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi
- Dr. Chirashree Ghosh, Professor, Department of Environmental Studies, University of Delhi, Delhi