	National Institute of Technology Meghalaya An Institute of National Importance	**CURRICULUM**

Programme	**Master of Technology**	Year of Regulation	**2025**
Department	**Civil Engineering**	Semester	**I**

Course Code	Course Name	Pre-requisite	Credit Structure				Marks Distribution			
			L	T	P	C	INT	MID	END	Total
CE 543	**Soil and Groundwater Remediation**	**NIL**	**3**	**0**	**0**	**3**	**50**	**50**	**100**	**200**

Course Objectives	1. To understand the nature, sources, and types of soil and groundwater contamination. 2. To study contaminant transport mechanisms in the subsurface environment. 3. To explore in-situ and ex-situ remediation technologies. 4. To evaluate the design and performance of remediation systems. 5. To understand regulatory frameworks and sustainable remediation practices.	Course Outcomes	CO1: Able to identify sources and types of contaminants affecting soil and groundwater quality. CO2: Able to explain contaminant transport and fate in the subsurface environment. CO3: Able to select appropriate remediation technologies based on site conditions and contaminant characteristics. CO4: Able to evaluate and design remediation systems for polluted soil and aquifers. CO5: Able to apply environmental regulations and sustainable remediation approaches in real-world scenarios.

SYLLABUS

No.	Content	Hours	COs
I	**Introduction to Soil and Groundwater Contamination:** Sources and types of contamination: industrial waste, leachate, agricultural runoff, petroleum hydrocarbons, heavy metals, and emerging pollutants; Characteristics of contaminated sites; Impact of contamination on environment and public health	6	CO1, CO2
II	**Subsurface Contaminant Transport:** Soil properties affecting transport: porosity, permeability, adsorption; Groundwater flow and aquifer characteristics; Contaminant transport mechanisms: advection, dispersion, diffusion, retardation, degradation; Concept of contaminant plume	6	CO2, CO3, CO4
III	**Site Assessment and Monitoring:** Environmental site assessment (Phase I and II); Soil and groundwater sampling techniques; Monitoring well installation and testing; Use of GIS and remote sensing in site investigation	5	CO2, CO3, CO4
IV	**In-Situ Remediation Technologies:** Soil vapor extraction (SVE); Air sparging; Bioremediation and phytoremediation; In-situ chemical oxidation/reduction; Permeable reactive barriers (PRBs)	7	CO2, CO3, CO4
V	**Ex-Situ Remediation Technologies:** Soil washing, soil flushing; Pump-and-treat systems; Excavation and landfilling; Thermal desorption and incineration; Slurry-phase bioreactors	9	CO4, CO5
VI	**Design, Sustainability, and Regulation:** Design considerations for remediation systems; Life cycle assessment and cost analysis of remediation technologies; Environmental regulations: CPCB guidelines, US EPA standards; Sustainable remediation approaches and green remediation principles; Case studies of successful remediation projects in India and globally	9	CO4, CO5
	Total Hours	**42**	

Essential Readings

1. Cheremisinoff, N.P., Groundwater Remediation: A Practical Guide for Environmental Engineers and Scientists, Wiley, 2017
2. Hou, D Sustainable Remediation of Contaminated Soil and Groundwater: Materials, Processes, and Assessment, Elsevier , 2020
3. Ok, Y.S, Rinklebe J., Hou, D.,Tsang, D. C.W., Tack, F.M.G, Soil and Groundwater Remediation Technologies, CRC Press, 2020

Supplementary Readings

1. National and State Pollution Control Board Reports and Manuals
2. U.S. EPA Documents – **Guidance on soil and groundwater remediation**