

# GUJARAT TECHNOLOGICAL UNIVERSITY

**BRANCH NAME: Environmental Science & Technology**  
**SUBJECT NAME: Design of Soil Pollution Control System**

**SUBJECT CODE: 2173511**  
**B.E. Semester: VII**

**Type of course:** Environmental Science & Technology

**Prerequisite:** A good fundamental knowledge of soil, its characteristic & use, causes of soil pollution, physico-chemical and biological treatment process along with basic design consideration.

**Rationale:** This subject is intended to make students aware about the basic fundamentals of soil, causes of its pollution and various treatment methods with their basic design aspects.

## Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks					Total Marks	
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
				PA	ALA	ESE	OEP			
3	1	3	7	70	20	10	20	10	20	150

L- Lectures; T- Tutorial/Teacher Guided Student Activity; P- Practical; C- Credit; ESE- End Semester Examination; PA- Progressive Assessment; OEP-Open Ended problem; AL-Active learning;

**Learning Objectives:** The learning objective of this subject is:

1. To create proper understanding about soil terminology,
2. To make aware about soil pollution and its source of pollution
3. To provide proper understanding about physical, chemical, biological characteristic of soil.
4. To provide knowledge about the various methods of soil treatment
5. To provide them hands on experience on sampling and analysis of soil
6. To provide the basic information about the designing aspects of various units

## Content:

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
1.	<b>Basic concept related to Soil Pollution:</b> The soil and its constitution. Functions and land uses. Main causes and the processes that contribute to the degradation of soil quality (erosion, chemical degradation and physical degradation). Sources of pollution ( <i>e.g.</i> urban areas, industrial areas, agriculture and livestock, landfills,	10	10

	sewage sludge, municipal solid waste dumps and hazardous waste), Soil quality		
2.	<p><b>Organic residues as soils fertilizers :</b></p> <p><b>Application of sewage sludge to soil:</b> Origins and treatment. Characterization. Assessing the risks associated with its application to soil. Determination of heavy metals in sludge. Adsorption / desorption of metals. Sequential extraction. Characterization of sludge from Portuguese wastewater treatment plants.</p> <p><b>Application of MSW compost to soil:</b> Origin. Characterization. Recovery. Risks associated with their application to the soil. Potential Guidelines.</p> <p>Risk of application of effluent to the ground water, fertigation, salinity and sodification, Typical dose-response curve for the macro, meso and micro-nutrients and toxic trace elements of fertilizers. Risks of soil contamination.</p>	15	25
3.	<p><b>Heavy metals in soils:</b> Main sources of contamination. Behaviour of heavy metals in soil and soil-plant system. Determination of heavy metals in soils. Sequential extraction. Bioavailability. Transfer coefficients in soil-plant systems for the different forms of metal in soil. Symptoms of toxicity.</p> <p><b>Application of pesticides aspects of pollution related to their use:</b> Degradation in soil. Toxicity and toxicological classes. Analysis of toxicological effects. Determination of pesticides in soils.</p> <p><b>Industrial activity as a source of contamination of soil:</b> Main types of industrial waste. The soil and water as the main final destinations. The particular case of mining activity.</p>	15	25
4.	<p><b>Soil remediation technique for removal of inorganic and organic pollutants:</b> On site (in situ) chemical, physical, soil vapour extraction, soil washing solidification/stabilization, electro-kinetic remediation thermal and biological methods. Off site (ex-situ, on-site and off-site): chemical methods, Physical solidification /stabilization/ immobilization, thermal, and biological (bioremediation and phytoremediation), Biostimulation, Bioaugmentation, Isolation containment of the affected area.</p>	25	40

**Suggested Specification table with Marks (Theory):**

Unit No	Unit Title	Distribution of Theory Marks					
		R Level	U Level	A Level	N level	E level	Total
1	Basic concept related to Soil Pollution	6	3	1	0	0	10
2	Organic residues as soils fertilizers :	6	9	5	2	3	25
3	Heavy metals in soils, Application of pesticides aspects of pollution related to their use, Industrial activity as a source of contamination of soil:	6	9	5	2	3	25
4	Soil remediation technique for removal of inorganic and organic pollutants:	8	10	8	8	6	40

**Legends: R : Remembrance ; U = Understanding; A = Application; N= Analyze; E= Evaluate and above Levels (Revised Bloom’s Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table

**Reference Books:**

- Pierzynski, G.M., Sims, J.T., and Vance, G.F. (1994). Soils and Environmental Quality. Lewis Publishers. Florida.
- Alloway, B.J. (Editor) (1995). Heavy Metals in Soils. 2nd Edition. Blackie Academic and Professional. London.
- Schepart, B.S. (Editor) (1995). Bioremediation of Pollutants in Soil and Water, ASTM. Philadelphia.

- McBride, M.B. (1994). Environmental Chemistry of Soils. Oxford University Press. International Edition.
- Kearney, P.C., Roberts, T. (Editors) (1998). Pesticide Remediation in Soils and Water. John Wiley and Sons. International Edition.
- Wise, D.L., Trantolo, D.J., Cichon, E.J., Inyang, H.I., Stottmeister (Editors) (2000). Remediation Engineering of Contaminated Soils. Marcel Dekker, Inc. New York.
- Leschber, R., Davis, R.D., L'Hermite, P. (Editors) (1985). Chemical Methods for Assessing Bio-Available Metals in Sludges and Soils. Elsevier Applied Science Publishers. London.
- Pinto, P.S.S. (Editor) (1998). Environmental Geotechnics. Volume II – Remediation of Polluted Land and Abandoned Landfills. A.A. Balkema/Rotterdam/Brookfield.
- Calvin Rose, An Introduction to the Environmental Physics of Soil, Water and Water Sheds, Cambridge University Press, 2004.
- Paul Nathanail C. and Paul Bardos R., Reclamation of Contaminated Land, John Wiley & Sons Limited, 2004.
- Hari D. Sharma and Krishna R. Reddy, Geo-Environmental Engineering : Site Remediation, Water Contaminant and Emerging Water Management Technologies, John Wiley & Sons Limited, 2004.
- Marcel Vander Perk, Soil and Water Contamination from Molecular to Catchment Scale, Taylor & Francis, 2006.
- William J. Deutsch, Groundwater Geochemistry : Fundamentals and Applications to Contamination, Lewis Publishers, 1997.

**Course Outcome:** On successful completion of this course unit, the student should be able to:

1. Have knowledge on the different sources of soil pollution as well as the different types of pollutants generated by them.
2. To identify the different types of soil decontamination/remediation methods, their application fundamentals and their major advantages and constraints:
  - I. Constructive techniques versus treatment techniques; In situ versus ex situ techniques;
  - II. Physical, chemical, solidification/stabilization/immobilization, thermal, and biological techniques.

**List of Experiments:**

Minimum 5 practical to be performed and remaining time should be allotted to open-ended projects/study reports/latest outcomes in technology study:-

**PRACTICALS (ANYFIVE):**

1	Determination of moisture content
2	Determination of specific gravity
3	Determination of permeability
4	Determination of porosity

<b>5</b>	Grain size analysis: Sieve analysis
<b>6</b>	Determination of Bulk density
<b>7</b>	Determination of soil reaction (pH)
<b>8</b>	Determination of Electrical conductivity
<b>9</b>	Determination of Soil Texture – International Pipette Method (Mechanical
<b>10</b>	Determination of Organic carbon in soil
<b>11</b>	Determination of Calcium carbonate(free lime) in soil
<b>12</b>	Determination of Nitrogen in soil
<b>13</b>	Determination of Phosphorous in soil
<b>14</b>	Determination of Sodium on flame photometer

**Equipment:** Glass wares, Weighing balance, Sieve analysis apparatus, Hot air Oven, Ammonical-nitrogen assembly, pH meter, Conductivity meter etc.

**Open ended Projects:**

- Sampling of Soil
- Physical analysis of Soil
- Chemical analysis of sludge generated from industries