

## The Hebrew University of Jerusalem

Syllabus

## WATER QUALITY IMPROVEMENT AND RECLAMATION - 71612

*Last update 30-10-2024* 

<u>HU Credits:</u> 3

Degree/Cycle: 1st degree (Bachelor)

Responsible Department: Soil and Water Sciences

<u>Academic year:</u> 0

<u>Semester:</u> 1st Semester

Teaching Languages: Hebrew

<u>Campus:</u> Rehovot

Course/Module Coordinator: Sara Elhanany

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Coordinator Office Hours: by appointment

<u>Teaching Staff:</u> Ms. Sara Elhanany

## Course/Module description:

The course focuses on understanding the tools and methods required for the treatment and preservation of the quality of natural water sources in aquifers. It also aims to provide students with basic knowledge of water treatment processes for water and wastewater, as well as their recycling, to protect human health, soil, and the aquatic environment. Emphasis is placed on sustainable water management approaches, ensuring the protection and efficient use of water resources.

## Course/Module aims:

This course provides students with basic knowledge on key topics, including the quality of the natural water resources in Israel, water pollutants, monitoring technologies and remediation methods based on risk assessment. Students will also learn about water and wastewater treatment processes, reclamation techniques, and the water quality standards required to protect human health, soil, and aquatic ecosystems. The course emphasizes both theoretical and practical aspects of sustainable water management.

Learning outcomes - On successful completion of this module, students should be able to:

Upon successful completion of this course, students will be able to:

- Characterize the evolving quality of water resources and identify pollution sources using advanced monitoring techniques.

- Apply corrective measures to preserve and restore both the quantity and quality of water resources.

- Recognize various remediation methods for water sources, as well as treatment techniques for wastewater and drinking water.

<u>Attendance requirements(%):</u> 100

*Teaching arrangement and method of instruction: lectures, exercises, quiz and Study tour* 

Course/Module Content:

1. Introduction: Sustainable Management of Water Resources in Israel with Emphasis on Preserving Water Quality – Challenges and Solutions

2. Pollution of the Saturated and Unsaturated Zones by Volatile Organic Compounds (VOCs) – Characteristics of the pollutants, their movement in the subsurface, decomposition pathways, spatial detection challenges, environmental implications, exposure routes, and health risks. Overview of the scope of the problem globally and in Israel, with case studies from Israel and abroad.

3. Approaches and Technologies for Remediation and Restoration of Contaminated Aquifers by Volatile Organic Compounds – Treatment approaches including pumpand-treat, hydrological containment, natural attenuation, and in-situ treatment. Insitu technologies such as chemical oxidation, chemical reduction, biodegradation, physical barriers, vapor extraction from the unsaturated zone, and combinations of these methods. Case study: In-situ chemical oxidation (ISCO) for the remediation of aquifers contaminated with chlorinated solvents (DNAPL).

4. Pollution by Light Non-Aqueous Phase Liquids (LNAPL) such as Fuels and Their Remediation Methods – Characterization of LNAPLs, their movement and spread in the subsurface, accumulation, phase transitions, solute transport within groundwater, advection, dispersion, sorption, and degradation. Remediation technologies for fuel lenses and dissolved fuel in groundwater: removal of fuel lenses, treatment of dissolved fuel, chemical oxidation, biological treatment via oxygenation (EBR ISOC), and integrated methods such as SVE-AS and recirculation wells. Natural attenuation as a remediation approach, with advanced methods for characterizing and accelerating biogeochemical and microbial processes in groundwater.

5. Use of Stable Isotopes for Characterizing and Identifying Biodegradation Processes of Organic Pollutants in Soil and Groundwater – What is isotopic fractionation, the principle behind the method, the Rayleigh equation, examples of the method's application, and its use as a decision-making tool for selecting appropriate remediation techniques for specific sites.

6. Biological Reduction and Degradation of Chlorinated Organic Pollutants at source zones (ISB, ISCR). Use of biological reactors for ex-situ treatment and the approach for widespread contamination in aquifers through hydrological containment -Principles of biological treatment via natural degradation pathways, with case studies demonstrating the application of these methods.

7. Risk Assessment as a Basis for Choosing Remediation Strategies for Contaminated Water Sources, and Principles of Numerical Modeling – The use of numerical models to predict flow and pollutant transport for risk assessment and to develop remediation plans for widespread aquifer contamination. Development of a risk-based corrective action plan (IRBCA) in Israel.

8. Water Quality Standards and Regulations for Drinking Water and the Considerations for Their Establishment – Principles for setting drinking water quality standards globally and in Israel, chemical, bacterial, physical, and organoleptic parameters, the multi-barrier approach to ensuring drinking water quality, and specific references in Israeli standards for different water sources such as surface water, desalinated water, and the issue of water fluoridation in Israel.

9. Principles of Water Treatment - Objectives of water treatment technologies, an

overview of basic water treatment processes: coagulation, sedimentation, filtration, desalination, adsorption, ion exchange, disinfection, and their implementation in Israel.

10. Well head treatments in Israel (Lecture + Tour) -

• Lecture: Importance of well tretment, support mechanisms for encouraging well rehabilitation in Israel, the scope of rehabilitation efforts, and the main technologies applied.

• Tour: Visit facilities for contaminant removal from drinking water wells (in Nes Ziona and Rehovot).

11. Principles of Wastewater Treatment and Reclaimed Water Reuse in Israel – Introduction to basic concepts of wastewater and reclaimed water characterization, wastewater treatment technologies and processes, reclaimed water reuse in Israel, regulations for determining their quality and impact on the environment,

groundwater, soil, and agricultural produce. Pre-treatment guidelines for industrial wastewater and the issue of micropollutants in reclaimed water and their potential impact on reuse and use as markers.

12. Field Trip to Key Water Management Facilities in Israel – Examples include desalination plants, wastewater treatment and reuse facilities, stormwater recharge and pollution prevention facilities, groundwater remediation facilities, or water supply treatment facilities. The tour itinerary will be determined during the course based on field constraints and communicated near the event date.

13. Guest Lectures from Israeli Water Sector Professionals Presenting Their Work:
Challenges and dilemmas in water management planning and presentation of the national master plan – Planning Division, Israel Water Authority.

• Water quality assurance at Mekorot, Israel's main water supplier – Water Quality Unit, Mekorot.

• Final Summary Lecture

Required Reading:

Viessman, Jr., W. and Hammer, M. J. Water Supply and Pollution Control. 8th, Edition. Harper Collins College Publishers, New York 2014 B.H. Kueper, H.F. Stroo, C.M. Ward Editors, Chlorinated Solvents Source Zone Remediation, Springer Science + Business Media, New York 2014 גבירצמן, חיים. משאבי המים של ישראל.(תשע"ט)מהדורה מורחבת ומעודכנת. הוצאת יד בן-צבי

Additional Reading Material:

<u>Grading Scheme:</u> Written Exam % 70 Submission assignments during the semester: Exercises / Essays / Audits / Reports / Forum / Simulation / others 20 % Attendance / Participation in Field Excursion 10 %

Additional information:

There may be surprise exams during classes that will count as bonus points: 1.Final examination - 70% 2.Participation, quiz and assignments - 20% 3.Field trip and report – 10% (if trip will not be feasible the 10% will be added to section2 (participation and assignments)