Wastewater Treatment Engineering – 3 credits

(Requirement course)

Fall semester

Coordinator	**Nguyen Thi Van Ha**
Credits	4,5 ECTS (selective course), 33.75 in-class hours
Lecturers	Thai PhuongVu (HCMUNRE, Vietnam) Huynh Thi Ngoc Han (HCMUNRE, Vietnam) Ton That Lang (HCMUNRE, Vietnam) Le Hoang Nghiem (HCMUNRE, Vietnam)
Level	MSc and PhD courses
Host institution	Faculty of Environment, HCMUNRE, Vietnam
Course duration	15 weeks (Fall Semester)

Summary

This course introduces knowledge about advanced wastewater engineering applied for industrial wastewater treatment meeting wastewater reuse needs and collecting valid metals. The course provides engineering related to the membrane (MBR), nutrient (N, P), heavy metals, advanced oxidation, waste sludge.

Target student audiences

Master and PhD students study about environmental management, environmental sciences, environmental engineering, civil engineering.

Prerequisites

Required courses (or equivalents):

- Environmental treatment engineering (as undergraduate)

Aims and objectives

- Introduce knowledge about advanced wastewater treatment technologies,
- Supply knowledge about advanced wastewater treatment engineering related to pollutants difficult to be treated by normal engineering (taught as undergraduate),
- Determine suitable technologies/engineering apply to treat a certain wastewater type meeting water reuse needs and collected by-products.

Course goals *(CGs)*	***Course goal description***
CG1	Understand advanced wastewater treatment technologies and engineering.
CG2	Proficiently apply advanced wastewater treatment engineering for a certain wastewater type.
CG3	Appropriate use of supplied knowledge to develop different wastewater treatment engineering.
CG4	Develop skills, logical thinking, problem-solving skills meeting the needs of independent and group work.

General learning outcomes:

By the end of the course, successful students will achieve the following course expected learning outcomes (CELO):

CELO	**CELO Description**
Knowledge and Understanding:	
CELO1	Gain basic knowledge about advanced technologies and engineering. Understand the application of advanced technologies and engineering in wastewater treatment.
CELO2	Determine suitably advanced technologies and engineering for wastewater treatment Apply advanced treatment technologies/engineering for a certain wastewater type.
CELO3	Understand and implement the treatment principles Assess ability and feasibility of advanced treatment technologies/engineering applied for the treatment
CELO4	Develop treatment system based on advanced treatment engineering Develop relationship experiment and research projects
Skills outcome	
CELO5	Look up, collect information and documents on advanced wastewater treatment engineering. Review new publishes to apply for new cases.
CELO6	Develop critical thinking skills during group work; Propose the treatment solutions for environmental protection activities and water reuse.

Overview of sessions and teaching methods

The course will make most of interactive and self-reflective methods of teaching and learning and, where possible, avoid standing lectures and presentations.

Learning methods

- Literature review
- Video presentations
- Interviews, fieldtrip, group work, written articles/essay
- Project Based Learning
- Case studies such as: wastewater treatment of new projects.

Overview of learning sessions

Chapter	Description	Credit hours	Lectures	Practice and Discussion
Chapter 1	Advanced wastewater treatment 1.1 Introduction 1.2 Principle and application of membrane 1.3 Typical examples	9	3	6
Chapter 2	Annamox process for denitrogen 2.1 Nitrogen discharge 2.2 Denitrogen 2.3 Nitrogen transformation 2.4 Treatment condition 2.5 Advantage and disadvantage	9	3	6
Chapter 3	Advanced oxidation process (AOP) 3.1 Introduction 3.2 Application 3.3 Treatment processes 3.4 Application condition	9	3	6
Chapter 4	Heavy metal treatment 4.1 Metal characteristics 4.2 Treatment technologies 4.3 Treatment engineering	9	3	6
Chapter 5	Sludge treatment engineering 5.1 Sludge sources 5.2 Treatment engineering	9	3	6
Total		**45**	**15**	**30**

1 credit hour = 45 minutes

Course workload

The table below summarizes course workload distribution:

Activities	**Learning outcomes**	**Assessment**	**Estimated workload (hours)**
In-class activities (33.75 hours)			
Lectures	Understanding theories, concepts and principles Understanding various technologies and engineering Understanding pollutant transformation in different phases	Class participation	10
Moderated in-class discussions	Understanding various application for wastewater treatment Determining suitable engineering for treating a certain wastewater type Developing experiment and treatment system	Class participation and preparedness for discussions	10
In-class assignments, field assignment	Assessing wastewater characteristics Analyzing and choosing technologies and engineering for treatment Applying advanced treatment engineering for real wastewater	Class participation and preparedness for assignments	8.75
Group presentation	Skilling to apply advanced engineering, developing advanced engineering application and defending the ideas presented in report	Quality of group assignments and individual presentations	5
Independent/group work (80 hours)			

Group work assignment: - Contribution to the group case-study projects - Contribution to the preparation and delivery of individual presentation	Ability to interpret data of pollutants and wastewater Choose suitably advanced treatment engineering Ability to integrate treatment components into system Select one typical case of wastewater to apply for treatment	Quality of group assignments and individual presentations Quality of essay	35
Course individual assignment	Ability to summarize advanced wastewater treatment technologies and 13.5engineering Select one real wastewater type and choose a suitably advanced treatment engineering Suggest one wastewater treatment system with advanced treatment engineering applied. Develop research/experiment project	Quality of developed essay	250
Group presentation	Skilling to interpret technologies and engineering, and to apply the them for real wastewater treatment	Quality of group assignments	20
Total			**113.5**

Grading

The students' performance will be based on the following:

Assessment

- Progress assessment (40%):
  - Quiz/Midterm examination (10%): students have to complete the quiz or Mid-term report.
  - Homework (30%): Group essay on advanced wastewater treatment engineering.
- Final assessment (50%):
  - Group report (30%): The students will be divided into groups of 4-5 students and choose one suitable case study for treating advanced wastewater treatment.
  - Final examination (30%): examination or individual essay on experimental/research project for treating pollutants.

Evaluation

A (8.5 – 10)
B (7.0 – 8.4)
C (6.0 – 6.9)
D (5.0 – 5.0)

Course schedule

The overall schedule is provided below (3 hours/week):

Week	Chapter	Topic	Lecturer
1		Guide to the course – purpose, objectives, learning outcomes, teaching and learning method, assignment and grading.	Thai Phuong Vu Huynh Thi Ngoc Han
1-3	1	Advanced wastewater treatment 1.1 Introduction 1.2 Principal and application of membrane 1.3 Uniform examples	Thai Phuong Vu Le Hoang Nghiem
4-6	2	Annamox process for denitrogen 2.1 Nitrogen discharge 2.2 Denitrogen 2.3 Nitrogen transformation 2.4 Treatment condition 2.5 Advantage and disadvantage	Thai Phuong Vu Ton That Lang
7-9	3	Advanced oxidation Processes 3.1 Introduction 3.2 Application 3.3 Treatment processes 3.4 Application condition	Thai Phuong Vu
10-12	4	Heavy metal treatment 4.1 Metal characteristics 4.2 Treatment technologies 4.3 Treatment engineering	Thai Phuong Vu Huynh Thi Ngoc Han

13-15	5	Sludge treatment engineering 5.1 Sludge sources 5.2 Treatment engineering	Thai Phuong Vu Ton That Lang

Course assignments

Course assignments will constitute a multi-part project:

- Assignment #1 (mostly in-class) – Principles and applications of advanced treatment engineering.
- Assignment #2 (mostly in-class) – Determining suitably advanced treatment engineering.
- Assignment #3 (Homework) – Developing a new project for wastewater treatment.

Literature

- Literature in English:

Brillas, Enric, A review on the photoelectro-Fenton process as efficient electrochemical advanced oxidation for wastewater remediation. Treatment with UV light, sunlight, and coupling with conventional and other photo-assisted advanced technologies, Chemosphere, 2020. DOI: 10.1016/j.chemosphere.2020.126198

Khan, Afzal Husain; Khan, Nadeem A.; Ahmed, Sirajuddin; Dhingra, Aastha, et al., Application of advanced oxidation processes followed by different treatment technologies for hospital wastewater treatment, Journal of Cleaner Production (2020). DOI: 10.1016/j.jclepro.2020.122411.

Kumar, R. Vinoth; Barbosa, Marta O.; Ribeiro, Ana R.; Morales-Torres, Sergio; Pereira, M. Fernando R.; Silva, AdriÃ¡n M.T., Advanced oxidation technologies combined with direct contact membrane distillation for treatment of secondary municipal wastewater, Process Safety and Environmental Protection, 2020. DOI: 10.1016/j.psep.2020.03.008

Metcalf and Eddy. Wastewater Engineering Treatment Disposal Reuse. 4 Edition McGraw Hill. Hider Education. Civil Engineering Series. 1995.

Ponce-Robles, L.; Oller, I.; Polo-López, M.I.; Rivas-Ibáñez, G.; Malato, S., Microbiological evaluation of combined advanced chemical-biological oxidation technologies for the treatment of cork boiling wastewater, Science of The Total Environment, Vol. 687, 2019. DOI: 10.1016/j.scitotenv.2019.05.335

Simon Judd. The MBR Book: Principles and Application of Membrane Bioreactors for Water and Wastewater Treatment, 2nd Edition, Butterworth Heinemann, UK, 536 pp.

Weiner R. F. and Matthews R. A. Environmental Engineering, 4th Edition, Butterworth Heinemann, Amsterdam, 2014, 510 pp.

- Literature in Vietnamese:

Sổ tay xử lý nước – tập 1. Nhà xuất bản Xây dựng. Hà Nội. 2006.

Sổ tay xử lý nước – tập 2. Nhà xuất bản Xây dựng. Hà Nội. 2006.

Trịnh Xuân Lai. Xử lý nước thải công nghiệp. Nhà xuất bản Xây dựng. Hà Nội. 2005.