**Wastewater Treatment Engineering – 3 credits**

(Requirement course)

# Fall semester

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| 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.

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| **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):

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| --- | --- |
| **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.

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| **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

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| --- | --- | --- | --- | --- |
| **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:

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| --- | --- | --- | --- | --- | --- |
| **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:

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| 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):

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| --- | --- | --- | --- |
| **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](http://libgen.rs/scimag/10.1016%2Fj.chemosphere.2020.126198), [Chemosphere](http://libgen.rs/scimag/journals/4078), 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](http://libgen.rs/scimag/10.1016%2Fj.jclepro.2020.122411), [Journal of Cleaner Production](http://libgen.rs/scimag/journals/12709) (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](http://libgen.rs/scimag/10.1016%2Fj.psep.2020.03.008), [Process Safety and Environmental Protection](http://libgen.rs/scimag/journals/20187), 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](http://libgen.rs/scimag/10.1016%2Fj.scitotenv.2019.05.335), [Science of The Total Environment](http://libgen.rs/scimag/journals/21912), 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.