**Solid Waste and Hazardous Waste Treatment Engineering – 3 credits**

(Compulsory course)

**Spring semester, 2020-2021**

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| Cooordinator | **Nguyen Thi Van Ha** |
| Credits | 4.5 ECTS (Compulsory course), 33.75 in-class hours |
| Lecturers | Nguyen Xuan Truong (HCMUNRE, Vietnam)Nguyen Thi Van Ha (HCMUNRE, Vietnam)Le Hoang Nghiem (HCMUNRE, Vietnam)Huynh Thi Ngoc Han (HCMUNRE, Vietnam) |
| Level | MSc and PhD courses |
| Host institution | Faculty of Environment, HCMUNRE, Vietnam |
| Course duration | 15 weeks (Fall 2021 -2022) |

### Summary

This course provides specific and professional knowledge on municipal waste, industrial waste and hazardous waste such as: collection system, classification and transportation; Recycle and treatment technologies, sanitation disposal; legal responsibles, regulations, policies and incentives in Viet Nam and in some countries on solid waste and hazardous waste management.

Students will be able to calculate technical specification and requirements for installing equipment, facilities, designing and operating the waste treatment system. Students have the vision toward zero emission and are able to apply the circular economic concept to waste management.

### Target student audiences

Master or PhD students majoring in environmental engineering, environmental sciences, environmental management, etc.

### Prerequisites

Required courses (or equivalents): Environmental Science Foundation

### Aims and objectives

The course is aimed to introduce specific knowledge about solid waste and hazardous waste treatment engineering and orientate students’ capacity to circular economic and zero waste emission.

Students will develop their professional skills to be able to design and operate the waste treatment system and to study on advanced technologies.

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| **Course goals*****(CGs)*** | ***Course goal description*** |
| **CG1** | Explain and analyze waste database such as composition, characteristics and sources of different types of wastes as well as their impacts on the environment and human health. |
| **CG2** | Analyze and select effective routes for collection of waste, classification as well as waste transportation facilities; Promote waste minimization and on-site classification |
| **CG3** | Able to propose technology, design and operate facilities for recycling and treating solid waste and hazardous waste for the specific cases |
| **CG4** | Proficiently apply the regulations of solid waste and hazardous waste management on different subjects such as: disposers, collectors and transfers, and treatment investors, managers, etc. |
| **CG5** | Develop innovation skills, logical thinking, problem-solving skills and leadership for working in group to develop and assess a waste treatment design or an integrated waste management system.  |

### 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** | Compare the composition, characteristics and sources of different types of wastes. |
| **CELO2** | Analyze the adverse impacts of waste types on environment and health and requirement of integrated waste management. |
| **CELO3** | Analyze engineering specification and can select the waste sorting, collection, transfer systems which are suitable and efficiency for a specific case; Understand the smart waste management system. |
| **CELO4** | Assess and propose the suitable technology for recycling and treating municipal waste, industrial waste and hazardous waste. |
| **CELO5** | Institutional and stakeholder analysis on waste management. |
| **CELO6** | Compare legal legislations on solid waste and hazardous waste management versus disposers, collectors and transfers, and treatment investors, managers, etc. |
| Skills outcome |
| **CELO7** | Capable to apply advanced waste treatment technology, able to calculate and degsin waste recycle and treatment facilities such as: composting, incinerator or sanitation landfill |
| **CELO8** | Work in group to design or operate a practical model of waste treatment facilities. |
| Responsibility skills |
| **CELO9** | Develop innovation, logical thinking, problem-solving capacity and leadership for working in group on waste management |

### 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** | * Video presentations
* Fieldtrip
* Problem Based Learning
* Group Based Learning
* Project cased study
* Literature review
* Calculation assignments
* Case studies
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***Overview of learning sessions***

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| --- | --- | --- | --- | --- |
| **Chapter** | **Description** | **Credit hours** | **Lectures** | **Practice and Discussion** |
| **Chapter 1** | Course descriptionIntroduction on waste treatment and management  | 1.53 | 1.53 | 00 |
| **Chapter 2** | Legal legislation and practical experience on municipal waste management | 4.5 | 3 | 1.5 |
| **Chapter 3** | Solid waste collection system | 3 | 3 | 0 |
| **Chapter 4** | Solid waste transferring and transportation system | 3 | 1.5 | 1.5 |
| **Chapter 5** | Solid waste recycling system | 3 | 3 | 0 |
| **Chapter 6** | Waste treatment principles and engineering | 3 | 3 | 0 |
| **Chapter 7** | Composting technology  | 3 | 2 | 1 |
| **Chapter 8** | Sanitation Landfill | 4.5 | 3.5 | 1 |
| **Chapter 9** | Waste burning Technology | 4.5 | 3.5 | 1 |
| **Chapter 10** | Hazardous waste management | 3 | 3 | 0 |
|  | Students’ projects | 9 | 0 | 9 |
|  | **Total** | **45** | **30** | **15** |

### 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, methodology and tools | Class participation | 6 |
| Moderated in-class discussions | Understanding various policy and management contexts and common problems in integrated solid waste management. | Class participation and preparedness for discussions | 10 |
| In-class assignments, field assignment | Understanding various technology and facilities (principles, design, operation and maintenance) of waste treatment.Applying calculation for designing the waste treatment facilities. | Class participation and preparedness for assignments | 10 |
| Reading and discussion of assigned papers for seminars and preparation for lectures | Familiarity with and ability to critically and creatively discuss key concepts, tools and methods as presented in the literature | Class participation, creative and active contribution to discussion | 2.5 |
| Group presentation | Ability to interpret data, to analyze audience, and to use the concepts, tools, and methods for communicating and defending the ideas presented in report | Quality of group assignments and individual presentations | 5 |
| **Independent work (75 hours)** |
| Group work:* Contribution to the group case-study projects
* Contribution to the preparation and delivery of individual presentation
* Contribution to the web-application
 | Ability to interpret data, to analyze audience, and to use the concepts, tools, and methods for communicating information to all participantsSelect one kind of waste and one facility to treat this waste; check the technology diagram, engineering design calculation and efficiency | Quality of group assignments and individual presentationsQuality of essay | 40 |
| Course group assignment | Ability to conceptualize and frame an integrated waste management, find related literature and data, interpret data, use the concepts, tools and methods covered in the course, and draw the policy/management relevant to achieve circular economic in the integrated waste management proposed for the selected waste above.Select one kind of wastes and apply circular economic to design the integrated waste management | Quality of developed essay | 30 |
| Group presentation | Ability to interpret data, to analyze audience, and to use the concepts, tools, and methods for communicating and defending the ideas presented in report | Quality of group assignments and individual presentations | 10 |
| ***Total*** |  |  | ***113.75*** |

### Grading

The students’ performance will be based on the following:

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| Assessment | * Progress assessment (40%):

Assignments in class and Homework  * Final assessment (60%):
* Group report (30%): The students will be divided into groups of 2 - 3 students and choose one case study to analyze the success and failures of the waste management and proposed the integrated waste management for this case and then withdrawn the learnt lessons which could be transferred to Viet Nam or developing countries.
* Final examination (30%)
 |
| Evaluation | A (8.5 – 10)B (7.0 – 8.4)C (5.5 – 6.9)D (4.0 – 5.4) |

### Course schedule

The overall schedule is provided below:

### Course schedule

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| --- | --- | --- | --- |
| **Week** | **Chapter** | **Topic** | **Lecturer** |
| Week 1 - 2 | 1  | - Guide to the course – purpose, objectives, learning outcomes, teaching and learning method, assignment and grading.**Chapter 1 – Introduction of solid waste and Waste management** 1.1. Composition, characteristics and sources of different types of wastes1.2. Impacts of waste disposal on environment and human health.1.3. Development history of solid waste management1.4. Solid waste emission in industrial society1.5. Urban waste management system1.6. Solid waste management of HCM City | Nguyen Thi Van Ha |
| Week 2 -3 | 1 | **Chapter 2 – Legislation and experience of urban municipal waste management**  2.1. Current urban municipal waste management in Vietnam 2.2. Legislation base for solid waste management in Vietnam2.3. Difficulties and barriers of municipal waste management in Vietnam2.4. The Practical experience of municipal waste management in other countries2.5. The integrated waste management systemAssignment #1 | Nguyen Thi Van Ha;  |
| Week 4 | 2 | **Chapter 3 – Solid waste collection system** 3.1. Municipal waste emission trends in Vietnam 3.2. Solid waste collection system 3.3. Smart collection system for solid waste3.4. Identify the solid waste collection routesAssignment #2 | Nguyen Xuan Truong |
| Week 5 | 3 | **Chapter 4 – Solid waste transfer and transportation system** 4.1. Needs of solid waste transfer station4.2. Classification of SW transfer station4.3. Waste transportation facilities 4.4. Important issues for designing the transfer station4.5. Select the preferable locations of transfer stations | Nguyen Xuan Truong |
| Week6 | 7 | **Chapter 5 – Solid waste recycling** 5.1. Recycling technologies for normal recycled wastes5.2. Recycling industrial inorganic wastes5.3. Recycling industrial organic wastes5.4. Market and recycled materials/products | Nguyen Xuan Truong |
| Week7 | 5 | **Chapter 6 –Solid waste treatment principles** 6.1 Mechanic treatment process6.2 Thermal treatment process6.3 Biological and chemical treatment | Huynh Thi Ngoc Han |
| Week8 | 6 | **Chapter 7 – Composting**  7.1. Composting process and their control factors7.2. Anaerobic composting7.3. Aerobic compostingAssignment | Huynh Thi Ngoc Han |
| Week9-10 | 7 | **Chapter 8 – Sanitation landfill**8.1. Landfill design and operation regulations in Vietnam8.2. Landfill classification8.3. Location selection8.4. Waste degradable process8.5. Air emission and control8.6. Leachate control8.7. Operation, monitoring and closure of landfillAssignment | Nguyen Thi Van Ha |
| Week10 - 11 |  | **Chapter 9 –Incinerator**9.1 Incinerator design and operation regulations in Vietnam9.2. Incinerator classification8.3. Advantage and disadvantage of i Location selection8.4. Burning process8.5. Air emission and control8.6. Heat balance and control8.7. Advanced technologies (gasification, plasma incinerator)Assignment | Huynh Thi Ngoc Han |
| Week12 |  | **Chapter 10 –Hazardous waste management**10.1. Characteristics and classification10.2. Government management for hazardous waste10.3.Hazardous waste management10.4.Advanced treatment methodsAssignment | Nguyen Xuan Truong |
| Week13 |  | **Group presentation** Assignment: Present the composting project | Nguyen Thi Van Ha, Huynh Thi Ngoc Han |
| Week14 |  | **Group presentation** Assignment: Present the sanitation landfill project for municipal waste  | Nguyen Thi Van Ha, Huynh Thi Ngoc Han |
| Week15 |  | **Group presentation** Assignment: Present the incinerator project for municipal waste; or hospital waste  | Huynh Thi Ngoc Han, Nguyen Xuan Truong |

### Course assignments

Course assignments will constitute a multi-part project:

* Assignment #1 (mostly in-class and a part of home reading) – Policy and stakeholder analysis for managing one kind of waste.
* Assignment #2 (mostly in-class) – Calculate the facilities for the sorted- waste collection from the district.
* Assignment #3 (home assignment) – Select one kind of wastes and select the technology, check the engineering design calculation for the proposed facilities for treatment (composting, burning, dumping, etc.) Calculate cost benefit ratio, net present value, etc.
* Assignment #4 (mostly in-class) – Prepare the report and presentation and defend for the proposed integrated waste management system.

### Literature

Schmidt, Michael; Glasson, John; Emmelin, Lars and Hendrike Helbron, 2008. Standards and Thresholds for Impact Assessment. Environmental Protection in the European Union ISSN 1613-8694. 487pp.

* Literature in English:
1. [John N.Hahladakis](https://www.sciencedirect.com/science/article/pii/B9780128178805000190#!)**,** Plastic waste in a circular economy [Plastic Waste and Recycling](https://www.sciencedirect.com/science/book/9780128178805), 2020.
2. Annelise, M. de Jong, 2021. The Potential of Plastic Reuse for Manufacturing: A Case Study into Circular Business Models for an On-Line Marketplace, Sustainability.
3. Ruohomaa, H., Ivanova, N., 2019. From solid waste management towards the circular economy and digital driven symbiosis, IOP Conference Series: Earth and Environmental Science.
4. [Obiora, B. Ezeudu](https://sciprofiles.com/profile/834721), [Tochukwu, S. Ezeudu](https://sciprofiles.com/profile/834785), 2019. Implementation of Circular Economy Principles in Industrial Solid Waste Management: Case Studies from a Developing Economy (Nigeria), Recycling.
5. Malinauskaite, J, et.al. 2017, Municipal solid waste management and waste-to-energy in the context of a circular economy and energy recycling in Europe, Energy.
6. Elisabetta, Allevi, et. al., 2021. Municipal solid waste management in circular economy: A sequential optimization model, Energy Economics.
7. Shikha, Dahiya et.al., 2017. Food waste biorefinery: Sustainable strategy for circular bioeconomy. [Bioresource Technology](https://www.researchgate.net/journal/Bioresource-Technology-0960-8524) 248(Pt A). DOI:[10.1016/j.biortech.2017.07.176](http://dx.doi.org/10.1016/j.biortech.2017.07.176)
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* Literature in Vietnamese:
1. Nguyễn Đình Hòe, 2008. Môi trường và phát triển bền vững. Nhà xuất bản Giáo dục. Hà Nội .
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4. Đinh Xuân Thắng, 2011, Kỹ thuật lò đốt chất thải rắn nguy hại, NXB ĐHQG – HCM, 276 trang.
5. Nguyễn Văn Phước, Nguyễn Thị Thanh Phượng, 2006. Giáo trình kỹ thuật xử lý chất thải công nghiệp, NXBXD, 360 trang.
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7. Lâm Minh Triết và CTV, 2015. Kỹ thuật Môi trường, NXB ĐHQG – HCM.
8. Nguyễn Xuân Nguyên, Trần Quang Huy, 2004. Công nghệ xử lý rác và chất thải rắn, NXB KHKT –HN, 240 trang.
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10. Video