



Course Syllabus (Academic Year 2022)

Kanchanaburi Campus, Mahidol University

1. **Course No. and Title** : KAED 322 Environmental Unit Operations
Credit (study hours) : 3 (3-0-6)
2. **Program Name** : Bachelor of Engineering in
 Environmental Engineering and Disaster Management
3. **Course Module** : Required course (Environmental Engineering)
Pre/co-requisite : KAED 229 Hydraulic
4. **Class Semester** : 1st Semester 2nd Semester Academic Year 2022
5. **Class Schedule & Venue** : Mondays 13:00 – 16:00
6. **Class Coordinator** : Dr. Pensiri Prachakittikul
 Contact No.: 0860240919 Email: pensiri.prc@mahidol.edu

7. Course Description

Principles, calculation, designing and application of physical and chemical unit operations in water and wastewater treatment: screening, grit removal, equalization, mixing, coagulation and flocculation, sedimentation, floatation, filtration, chemical precipitation, ion-exchange, absorption and adsorption, and reverse osmosis

8. Course Learning Outcomes (CLOs)

| No. | CLOs | Expected Skills / Knowledge | | | PLOs |
|-----|---|---|---------------|---|----------------------|
| | | Specific | Generic | Knowledge | |
| 1 | Describe the role of various physico-chemical unit processes within water and wastewater treatment process, and the context of when they are applied. | <ul style="list-style-type: none"> - Systematic thinking - Problem identification SS1, SS2, SS7 | GS1, GS3, GS4 | -Sciences and Mathematics -Water and wastewater -Fluid mechanics, hydraulics, and hydrology K1-K12 | 1 (Reinforced) |
| 2 | Apply the fundamental concepts, and applications for the design of main unit operations in the field | <ul style="list-style-type: none"> - Problem solving - Ability to analyze - Practical design SS1-SS8 | GS1-GS4 | -Sciences and Mathematics -Water and wastewater | 1, 2 (Reinforced) |

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| | of environmental engineering such as coagulation-flocculation, sedimentation, thickening, flotation, aeration, adsorption, and filtration processes. | | | --Fluid mechanics, hydraulics, and hydrology K1-K12 | |
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9. Class Instructor List

9.1 Asst. Prof. Dr. Weerawut Chaiwat (WC) Mobile: 0845223098, Email: weerawut.cha@mahidol.edu

9.2 Dr. Pensiri Prachakittikul (PP) Mobile: 0860240919, Email: pensiri.prc@mahidol.edu

10. Course Outline

| Week | Date | Contents | CLOs | Teaching & Learning Method | Instructor |
|------|--------------------------------|--|------|--|------------|
| 1 | 8/08/2022 | - Introduction to physical and chemical unit operations - Mass balance/ Flow models/ Reactors | 1, 2 | Lecture/ problem-based learning/ Asking and answering questions | WC |
| 2 | 15/08/2022 | Screening / Grit removal I | 1, 2 | | WC |
| 3 | 22/08/2022 | Grit removal II / EQ tank | 1, 2 | | WC |
| 4 | 29/08/2022 | Agitation and mixing I | 1, 2 | QUIZ I / Lecture / problem-based learning | WC |
| 5 | 5/09/2022 | Agitation and mixing II | 1, 2 | Lecture/ problem-based learning/ Asking and answering questions | WC |
| 6 | 12/09/2022 | Sedimentation I – Free settling (Coagulation and flocculation) | 1, 2 | QUIZ II / Lecture/ problem-based learning | WC |
| 7 | 19/09/2022 | Sedimentation II – Hindered and compression settling | 1, 2 | Lecture/ problem-based learning/ Asking and answering questions | WC |
| 8 | 26/09/2022 | Sedimentation III – Flotation | 1,2 | QUIZ III / Lecture/ problem-based learning | WC |
| 9 | 3/10/2022 Mid-term Examination | | | | |
| 10 | 10/10/2022 | Basic principle of mass transfer | 1, 2 | Lecture/ problem-based | WC |

| Week | Date | Contents | CLOs | Teaching & Learning Method | Instructor |
|------|-------------------|---|------|---|------------|
| | | <ul style="list-style-type: none"> - Gas-liquid mass transfer (Oxygen transfer) - The two-film theory/ Mass transfer coefficient | | learning/ Asking and answering questions | |
| 11 | 17/10/2022 | Basic principle of mass transfer <ul style="list-style-type: none"> - Liquid-solid mass transfer - Filtration I – Depth filtration | 1, 2 | QUIZ IV/ Lecture / problem-based learning | WC |
| 12 | 31/10/2022 | Filtration II – Surface filtration | 1, 2 | Lecture/ problem-based learning/ Asking and answering questions | WC |
| 13 | 7/11/2022 | Adsorption I | 1,2 | QUIZ V/ Lecture / problem-based learning | WC |
| 14 | 14/11/2022 | Adsorption II | 1,2 | Lecture/ problem-based learning/ Asking and answering questions | WC |
| 15 | 21/11/2022 | Ion exchange | 1, 2 | | WC |
| 16 | 28/11/2022 | Poster and Excel calculation presentation of designed unit operations | 1, 2 | Oral presentation / project-based learning discussion | PP |
| 17 | Final Examination | | | | |

11. Course Assessment

| No. | Methods / Activities | Regulations | CLOs | Week | Weight Distribution (%) |
|------|------------------------|---|------|--------------------|-------------------------|
| 11.1 | Mid-term exam | <input checked="" type="checkbox"/> Content (Week 1-8) <input checked="" type="checkbox"/> Open book & calculator | 1,2 | 9 | 30 |
| 11.2 | Final exam | <input checked="" type="checkbox"/> Content (Week 10-16) <input checked="" type="checkbox"/> Open book & calculator | 1,2 | 17-18 | 30 |
| 11.3 | Quiz (3% x 5 times) | <input checked="" type="checkbox"/> Open book & calculator <input checked="" type="checkbox"/> Google form with limited time | 1, 2 | 4, 6, 8, 11, 13 | 15 |

| | | | | | |
|------|--|--|------|-----------------|------------|
| 11.4 | Group project - Fact sheet (10%) - Presentation (5%) | - A3 poster and calculation files of designed environmental unit operation must be submitted on google classroom by the deadline. - Scoring rubrics | 1,2 | 16 | 15 |
| 11.5 | Homework | Student must submit homework on Moodle platform by the deadline | 1, 2 | to be announced | 5 |
| 11.6 | Active Participation, Class Attendance | - Scoring rubric | 1, 2 | All | 5 |
| | | | | Total | 100 |

12. Grading System

Criterion-referenced evaluation

| Grade | Score | Grade | Score | Grade | Score | Grade | Score |
|-------|-------------|-------|-------------|-------|-------------|-------|-------------|
| A | $\geq 80\%$ | B | 70 – 74.99% | C | 60 – 64.99% | D | 50 – 54.99% |
| B+ | 75 – 79.99% | C+ | 65 – 69.99% | D+ | 55 – 59.99% | F | < 50 % |

13. References

13.1 McCabe WL, Smith JC, and Harriott P, Unit Operation for Chemical Engineering. New York: McGraw-Hill; 1993.

13.2 Reynolds and Richards, Unit Operations and Processes in Environmental Engineering. 2nd ed. PWS Publishing Company; 2002.

13.3 Metcalf & Eddy / Aecom, Wastewater Engineering Treatment and Resource Recovery, Fifth edition (Volume 1 and 2), McGraw-Hill Education, International Edition; 2014.

13.4 Theodore L, Dupont RR, and Ganeson K, Unit Operations in Environmental Engineering. John Wiley & Sons, Inc.; 2017.

Note:

| Program Learning Outcomes (PLOs) | |
|----------------------------------|---|
| PLO1 | Apply environmental engineering principles and knowledge to systematic solutions according to Professional Standards |
| PLO2 | Apply practical skills in environmental engineering and disaster management to real situations based on academic principles and professional ethics |
| Specific Skill (SS) | |

| | |
|---------------------------|---|
| SS1 | Assess quantity & quality of water resource demand and supply |
| SS2 | Assess quantity & quality of wastewater |
| SS3 | Understand concepts of unit conversion and can change units from ones to others |
| SS4 | Calculate mass and energy balances in basic environmental unit operations |
| SS5 | Understand rate of reaction and calculate rate constants and other related kinetic parameters |
| SS6 | Understand type of reactors and basically calculate volume of designed reactors |
| SS7 | Understand parameters, equations and operational principles of various physico-chemical treatment units |
| SS8 | Design physico-chemical treatment units and apply in water and wastewater treatment system |
| Generic Skill (GS) | |
| GS1 | Systematic thinking, problem solving and analytical skills |
| GS2 | Basic computer skills |
| GS3 | Disaster risk awareness |
| GS4 | Professional ethics and responsibilities |
| Knowledge (K) | |
| K1 | Water and analytical chemistry |
| K2 | Water and wastewater quality and characteristics |
| K3 | Chemical kinetics and basic reactor design |
| K4 | Material and energy balances |
| K5 | Flow measurement and hydraulics |
| K6 | Mass transfer |
| K7 | Screening and equalization tank |
| K8 | Mixing, coagulation and flocculation |
| K9 | Sedimentation and floatation |
| K10 | Adsorption |
| K11 | Ion exchange and membrane process |
| K12 | Filtration |