School of Civil and Environmental Engineering

Term 3, 2021

# CVEN4504 ADVANCED WATER AND WASTEWATER TREATMENT

## COURSE DETAILS

| | | |
|---|---|---|
| **Units of Credit** | **6** | |
| **Contact hours** | 4 hours per week | |
| **Class** | Mon 4:00PM - 6:00PM | Online |
| | Fri 11:00AM - 1:00PM | Online |
| **Course Coordinator and Lecturer** | Prof. T. David Waite | |
| | Email: d.waite@unsw.edu.au | |
| | Office: Room 114 (H22 – Vallentine Annexe) | |
| | Phone: 9385 5060 (via Teams) | |
| **Course Coordinator and Lecturer** | Dr. A. Ninh Pham | |
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| | Office: Room 108 (H22 – Vallentine Annexe) | |
| | Phone: 9385 5102 (via Teams) | |

## INFORMATION ABOUT THE COURSE

Prerequisites: CVEN3502

The course discusses both the fundamental concepts and practical aspects involved in the design of various conventional and advanced treatment unit processes to meet specified water quality standards with emphasis on removal of non-traditional and emerging contaminants.

## HANDBOOK DESCRIPTION

See link to virtual handbook -

https://www.handbook.unsw.edu.au/undergraduate/courses/2021/CVEN4504

## OBJECTIVES

To provide a comprehensive understanding of the fundamental concepts and design principles in both conventional and advanced water treatment unit processes.

## TEACHING STRATEGIES

The teaching strategies that will be used in this course are traditional lecture teaching combined with workshop and independent study.

The approaches to learning are:

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| **Private Study** | • Review lecture material and textbook<br>• Do set problems and assignments<br>• Join Moodle discussions of problems<br>• Reflect on class problems and assignments<br>• Download materials from Moodle<br>• Keep up with notices and find out marks via Moodle |
| **Lectures** | • Find out what you must learn<br>• See methods that are not in the textbook<br>• Follow worked examples<br>• Hear announcements on course changes |
| **Workshops** | • Be guided by Demonstrators<br>• Practice solving set problems<br>• Ask questions |
| **Assessments** | • Demonstrate your knowledge and skills<br>• Demonstrate higher understanding and problem solving |

## EXPECTED LEARNING OUTCOMES

This course is designed to address the learning outcomes below and the corresponding Engineers Australia Stage 1 Competency Standards for Professional Engineers as shown. The full list of Stage 1 Competency Standards may be found in Appendix A.

After successfully completing this course, you should be able to:

| | **Learning Outcome** | **EA Stage 1 Competencies** |
|---|---|---|
| 1. | *Identify important water quality parameters and various constituents that affect water quality.* | *PE1.3, PE1.5, PE3.1, PE3.4* |
| 2. | *Analyse the principles of chemical reactions and concepts involved in design of important treatment units in a conventional treatment plant including coagulation, flocculation, clarification, mixed-media filtration and disinfection.* | *PE1.1, PE1.2, PE1.5, PE2.1, PE2.2, PE2.3, PE3.3* |
| 3. | *Apply the various advanced treatment methods including:*<br>*a) advanced oxidation and reductive processes*<br>*b) membrane-based treatment processes*<br>*c) electrodialysis and capacitive deionization*<br>*d) adsorption and ion exchange processes*<br>*to produce water of high-quality standards.* | *PE1.1, PE1.3, PE1.5, PE2.1, PE2.2, PE3.3* |
| 4. | *Develop interpersonal and process management skills in team-work environments and the ability to evaluate and disseminate knowledge and technologies from published literature effectively in a written report and as a seminar presentation.* | *PE1.1, PE1.3, PE1.4, PE3.2, PE3.3, PE3.5, PE3.6* |

For each hour of contact it is expected that you will put in at least 1.5 hours of private study.

**COURSE PROGRAM**

**TRIMESTER 3 2021**

| Date | Topic | Lecture Content | Lecturer |
|---|---|---|---|
| 13/09/2021 (Week 1) | Introduction to Water Quality & Treatment Processes | • Australian Drinking Water Guidelines and water quality parameters<br>• Overview of water treatment unit processes | Pham |
| 20/09/2021 (Week 2) | Principles of Chemical Reactions | • Chemical reactions and stoichiometry<br>• Equilibrium reactions and thermodynamics of chemical reactions<br>• Reaction kinetics<br>• Reactions used in water treatment | Waite |
| 27/09/2021 (Week 3) | Coagulation & Flocculation | • Surface charge of particles in suspension<br>• Coagulants and mechanisms of coagulation<br>• Coagulation practices<br>• Flocculation modelling<br>• Flocculation practices | Pham |
| 04/10/2021 (Week 4)* | Clarification & Mixed-media Filtration | • Particle settling theory<br>• Conventional sedimentation basin design<br>• Alternative sedimentation processes<br>• Rapid filtration classification and filter media<br>• Models for rapid filter behaviour<br>• Rapid filter design | Pham |
| 11/10/2021 (Week 5) | Disinfection & Advanced Oxidation Processes | • Disinfection kinetics<br>• Design of disinfection contactors<br>• Disinfection with free and combined chlorine, chlorine dioxide, ozone and UV<br>• Advanced Oxidation Processes (AOP)<br>• Kinetics of AOPs and major factors affecting AOPs<br>• Types of AOPs | Waite |
| 18/10/2021 (Week 6) | ***Non-teaching week for all courses*** | | |
| 25/10/2021 (Week 7) | Membrane Processes | • Membrane classification, properties & configuration<br>• Filtration mechanism, permeate flux and fouling<br>• Process design of membrane filtration<br>• Application for reverse osmosis (RO)<br>• RO process description<br>• RO fundamentals and fouling | Waite |
| 01/11/2021 (Week 8) | Electrodialysis & Capacitive Deionization | • Fundamentals of ED and its applications<br>• ED process design and energy requirement<br>• Unique advantages of CDI and cell architectures<br>• Operational modes of a CDI system and key performance indicators<br>• Reactions at, and materials for CDI electrodes | Waite |

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|---|---|---|---|
| 08/11/2021<br>(Week 9) | Adsorption & Ion Exchange | • Fundamentals of adsorption & adsorption isotherms<br>• Powdered and granular activated carbon<br>• Fundamental of ion exchange and mechanisms<br>• Classification and properties of ion exchange media<br>• Ion exchange process configuration | Pham |
| 15/11/2021<br>(Week 10) | Residuals Management | • Sources and characterization of residuals<br>• Management of residual liquid stream & concentrate<br>• Management of sludges | Pham |

* There is no lecture on Monday (week 4) because it is the Labour Day (Public Holiday). A pre-recorded lecture will be provided.

## ASSESSMENT

The final grade for this course will normally be based on the sum of the scores from each of the assessment tasks. The formal exam scripts will not be returned but you are permitted to view the marked script. Students who perform poorly in the quizzes and assignment are strongly recommended to discuss progress with the lecturers during the term.

Note: The Coordinator reserves the right to adjust the final scores by scaling if agreed by the Head of School.

Details of each assessment component, the marks assigned to it and the dates of submission are set out below.

***Supplementary Examinations:***

Supplementary Examinations for Term 3 2021 will be held on Monday 10th to Friday 14th January 2022 (inclusive) should you be required to sit one. You are required to be available during these dates. Please do not to make any personal or travel arrangements during this period.

## PENALTIES

Late work will be penalised at the rate of 10% per day after the due time and date have expired. Otherwise, if required, apply for special consideration for an extension.

**ASSESSMENT OVERVIEW**

| Item | Length | Weighting | Learning outcomes assessed | Assessment Criteria | Due date and submission requirements | Deadline for absolute fail | Marks returned |
|---|---|---|---|---|---|---|---|
| *1. Quizzes* – All quizzes are individual assessments (25%)* | | | | | | | |
| Quiz 1 | 45 min (10 questions) | 5% | LO1, LO2 | Materials presented in wks 1 and 2 to be assessed | 03rd Oct 2021 (online by 11 pm) | Same date as the due date | 08th Oct 2021 |
| Quiz 2 | 45 min (10 questions) | 7.5% | LO1, LO2, LO3 | Materials presented in wks 3, 4 and 5 to be assessed | 24th Oct 2021 (online by 11 pm) | | One wk after the due date |
| Quiz 3 | 45 min (10 questions) | 7.5% | LO1, LO2, LO3 | Materials presented in wks 7, 8, 9 and 10 to be assessed | 21st Nov 2021 (online by 11 pm) | | One wk after the due date |
| Quiz 4 (consists of 7 weekly quizzes) | 20 min (5 questions) for each quiz | 5% | LO1, LO2, LO3, LO4 | Contents of the research papers distributed weekly to the groups to be assessed | 11 pm the night **before** the corresponding presentations | | One wk after the due date |
| *2. Assessments** – Group work assessments (25%)* | | | | | | | |
| Presentation | 20 min presentation + 10 min discussion time | 10% | LO1, LO2, LO3, LO4 | Details given on a separate assignment guidelines sheet and a marking rubric | 2 wks after the project topic is assigned. | Same date as the due date | One wk after the due date |
| Literature review | 10-page literature review (typed, 12 pt) | 10% | | | Literature review submitted to Turnitin | One wk after the due date | Two wks after the due date |
| Seminar engagement | Duration of the seminars | 5% | | Attendance and participation in the seminar discussion | Same day with the seminar | Same date as the seminar | End of wk 10 |
| *3. Final Exam* | 2 hr (closed book) | 50% | LO1, LO2, LO3 | All lecture materials presented from wks 1-10 | During the exam period | N/A | TBA |

**Quizzes will be uploaded on UNSW Moodle one week prior to the due dates and will be available for one week. Quizzes are individual assessments which will assess the concepts discussed during lectures and will have short-answer, multiple choice, true-false and/or calculation questions. Students can attempt the quizzes in their own time within that one-week period once. Please ensure that your computer is UNSW Moodle compatible before attempting the quizzes. Please check the following link for system requirement for UNSW Moodle and other information on UNSW Moodle.*

https://student.unsw.edu.au/moodle-support

*Please inform the course coordinator in advance if you are not able to take the quiz in the allotted week or regarding any computing problems.*

**Students are expected to form their own groups (2 students per group) and select the available research topics on a first-come-first-served basis. Group members and research topics must be finalized prior to Friday 24th September 2021. Research articles will be distributed to the groups two weeks prior to the groups' presentation dates (e.g., the first set of papers will be distributed on Friday week 1 to groups that present on Friday week 3).

Both presentation and literature review should be based primarily on the assigned research article(s) with focus given to (if applicable): a) the core hypothesis/findings of the articles, b) the key biogeochemical principles/processes and/or treatment technologies underpinning the work, c) environmental significance of the work, and d) current knowledge (by referring to previous publications), knowledge gaps and work required to fill these gaps. All students are expected to attend the group presentations and provide marks based on a given marking rubric. The final presentation mark is equally weighted from the average of the student mark and the average of the staff mark.

## RELEVANT RESOURCES

No textbook is recommended but material will be drawn from a variety of texts (see additional readings) and lecture handouts.

Additional material will be provided on UNSW - Moodle

Additional Reading (e-books and/or printed copies might be available at the UNSW library):

1. Water Treatment: Principles and Design, 3rd Edition, MWH, Wiley, 2012.
2. Water Quality Engineering: Physical/Chemical Treatment Processes, Benjamin & Lawler, Wiley 2013.

## DATES TO NOTE

Refer to MyUNSW for Important Dates available at:

https://student.unsw.edu.au/dates

## PLAGIARISM

Beware! An assignment that includes plagiarised material will receive a 0% Fail, and students who plagiarise may fail the course. Students who plagiarise are also liable to disciplinary action, including exclusion from enrolment.

Plagiarism is the use of another person's work or ideas as if they were your own. When it is necessary or desirable to use other people's material you should adequately acknowledge whose words or ideas they are and where you found them (giving the complete reference details, including page number(s)). The Learning Centre provides further information on what constitutes Plagiarism at:

http://www.lc.unsw.edu.au/onlib/plag.html

## ACADEMIC ADVICE

For information about:

- Notes on assessments and plagiarism;
- Special Considerations: student.unsw.edu.au/special-consideration;
- General and Program-specific questions: The Nucleus: Student Hub
- Year Managers and Grievance Officer of Teaching and Learning Committee, and
- CEVSOC/SURVSOC/CEPCA

Refer to Academic Advice on the School website available at:

https://intranet.civeng.unsw.edu.au/key-staff-to-contact-during-your-studies-at-unsw

**Appendix A: Engineers Australia (EA) Competencies**

*Stage 1 Competencies for Professional Engineers*

| | **Program Intended Learning Outcomes** |
|---|---|
| **PE1: Knowledge and Skill Base** | PE1.1 Comprehensive, theory-based understanding of underpinning fundamentals |
| | PE1.2 Conceptual understanding of underpinning maths, analysis, statistics, computing |
| | PE1.3 In-depth understanding of specialist bodies of knowledge |
| | PE1.4 Discernment of knowledge development and research directions |
| | PE1.5 Knowledge of engineering design practice |
| | PE1.6 Understanding of scope, principles, norms, accountabilities of sustainable engineering practice |
| **PE2: Engineering Application Ability** | PE2.1 Application of established engineering methods to complex problem solving |
| | PE2.2 Fluent application of engineering techniques, tools and resources |
| | PE2.3 Application of systematic engineering synthesis and design processes |
| | PE2.4 Application of systematic approaches to the conduct and management of engineering projects |
| **PE3: Professional and Personal Attributes** | PE3.1 Ethical conduct and professional accountability |
| | PE3.2 Effective oral and written communication (professional and lay domains) |
| | PE3.3 Creative, innovative and pro-active demeanour |
| | PE3.4 Professional use and management of information |
| | PE3.5 Orderly management of self, and professional conduct |
| | PE3.6 Effective team membership and team leadership |