Annexe A: New/Revised Course Content in OBTL+ Format

Course Overview

Expected Implementation in Academic Year	AY 2025-2026
Semester/Trimester/Others (specify approx. Start/End date)	Semester 2
Course Author * Faculty proposing/revising the course	Lee-Chua Lee Hong
Course Author Email	clhlee@ntu.edu.sg
Course Title	Membranes for Environmental Applications
Course Code	EN4102
Academic Units	3
Contact Hours	39
Research Experience Components	Not Applicable

Course Requisites (if applicable)

Pre-requisites	Year 3 standing
Co-requisites	
Pre-requisite to	
Mutually exclusive to	
Replacement course to	
Remarks (if any)	

Course Aims

Develop understanding of membrane technology in water reclamation processes. Familiarize with basic design concepts and technical management of a membrane-based water reclamation plant.

Course's Intended Learning Outcomes (ILOs)

Upon the successful completion of this course, you (student) would be able to:

ILO 1	Discuss the classifications, working principles, and applications of various membrane technologies.
ILO 2	Analyse the main factors (feed type, pressure, electrical potential etc.) determining separation performance and energy consumption.
ILO 3	Analyse product quality and quantity (rejection and recovery).
ILO 4	Relate various membrane plant designs to their advantages and limitations.
ILO 5	Apply control on adverse effects in membrane separation process (fouling, scaling, concentration polarisation, etc.)

Course Content

1. Introduction to Membrane Technology
2. Membrane Materials, Synthesis and Properties
3. Membrane Transport and Rejection
4. Membrane Fouling
5. Membrane Process Design
6. Membrane for Desalination
7. Membrane Bioreactor for Wastewater Treatment
8. Electrodialysis
9. Membrane for Gas and Air Separation
10. Membrane for Energy
11. Emerging Membrane Technologies

Reading and References (if applicable)

1. M. Mulder, 'Basic Principles of Membrane Technology', Springer, 1996.
2. Richard W. Baker, 'Membrane Technology and Applications', Wiley, 2012.
3. Enrico Drioli, Lidietta Giorno, "Encyclopedia of Membranes", Springer Berlin Heidelberg, 2016
4. Journal Papers

Teaching faculty will provide updated reading materials when it is available.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction to Membrane Technology	1, 2, 3	Lecture materials	In-person	Lecture & Tutorial
2	Membrane Materials, Synthesis and Properties	1, 2, 3	Lecture materials	In-person	Lecture & Tutorial
3	Membrane Materials, Synthesis and Properties;; Membrane Transport and Rejection	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
4	Membrane Transport and Rejection; Membrane Fouling	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
5	Membrane Fouling; Membrane Process Design	1, 2, 3, 4, 5	Lecturer materials	In-person	Lecture & Tutorial
6	Membrane Process Design; Membrane Desalination	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
7	Membrane Desalination; Membrane Bioreactor for Wastewater Treatment	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
8	Membrane Bioreactor for Wastewater Treatment	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
9	Electrodialysis	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
10	Membrane for Gas and Air Separation	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
11	Membrane for Energy	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
12	Membrane for Energy; Emerging Membrane Technologies	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial
13	Emerging Membrane Technologies	1, 2, 3, 4, 5	Lecture materials	In-person	Lecture & Tutorial

Learning and Teaching Approach

Approach	How does this approach support you in achieving the learning outcomes?
Lecture	Faculty will elaborate on complex content for deeper learning. You will be able to ask questions when in doubt.
Tutorial	Tutor will guide you in analysing and solving problems.

Assessment Structure

Assessment Components (includes both continuous and summative assessment)

No.	Component	ILO	Related PLO or Accreditation	Weightage	Description of Assessment Component	Team/Individual	Rubrics	Level of Understanding
1	Summative Assessment (EXAM): Final exam(Final Examination)	1,2,3,4,5	a, b, c	60	Physical written exam will be conducted in exam hall	Individual	Holistic	Relational
2	Continuous Assessment (CA): Test/Quiz(CA1: Quiz 1)	1,2,3	a, b, c	20	Physical written quiz session will be conducted in class	Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(CA2: Quiz 2)	1,2,3,4,5	a, b, c	20	Physical written quiz session will be conducted in class	Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

Formative Feedback

For CA1 and CA2, the questions and solutions will be discussed with you right after the quiz or in the subsequent tutorial classes. You will be informed of the median grade.

NTU Graduate Attributes/Competency Mapping

This course intends to develop the following graduate attributes and competencies (maximum 5 most relevant)

Attributes/Competency	Level
Care for Environment	Basic
Communication	Basic
Creative Thinking	Basic
Curiosity	Basic
Problem Solving	Basic

Course Policy

Policy (Academic Integrity)

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values. As a student, it is important that you recognize your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain of the definitions of any of these terms, you should go to the academic integrity website for more information. On the use of technological tools (such as Generative AI tools), different courses / assignments have different intended learning outcomes. Students should refer to the specific assignment instructions on their use and requirements and/or consult your instructors on how you can use these tools to help your learning. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Policy (General)

You are expected to complete all assigned pre-class readings and activities, attend all lectures and tutorials punctually and take all scheduled assignments and quizzes by due dates. You are expected to take responsibility to follow up with course notes, assignments and course related announcements for lectures and tutorials you have missed. You are expected to participate in all lectures and tutorials discussions and activities.

Policy (Absenteeism)

CAs make up a significant portion of your course grade. Absence from quiz without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for quiz.

Policy (Others, if applicable)

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