

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

Course Overview

The sections shown on this interface are based on the templates [UG OBTL+](#) or [PG OBTL+](#)

If you are revising/duplicating an existing course and do not see the pre-filled contents you expect in the subsequent sections e.g. Course Aims, Intended Learning Outcomes etc. please refer to [Data Transformation Status](#) for more information.

Expected Implementation in Academic Year	AY 2022-2023
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	Membrane Water Reclamation Technology
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

No	Topic	Lecture Hour	Tutorial Hour
1	Introduction to Membrane Technology	2	1
2	Membrane Materials and Synthesis	2	1
3	Membrane Properties and Characterisation	2	1
4	Membrane Transport and Rejection	2	1
5	Membrane Process Design (NF/RO Design)	2	1
6	Membrane Desalination and Reclamation	4	2
7	Forward Osmosis and Pressure Retarded Osmosis	2	1
8	Electrodialysis	1	0
9	Membrane Distillation	2	1
10	Membrane Fouling	3	2
11	Membrane Bioreactor	4	2
	Total	26	13

Reading and References (if applicable)

1. Mulder, M., 'Basic Principles of Membrane Technology', Springer, 1996.
2. Baker, Richard W., 'Membrane Technology and Applications', Wiley, 2012.

Planned Schedule

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
1	Introduction to Membrane Technology	1, 2, 3		In-person	Lecture & Tutorial
2	Membrane Materials and Synthesis	1, 2, 3		In-person	Lecture & Tutorial
3	Membrane Properties and Characterisation	1, 2, 3		In-person	Lecture & Tutorial
4	Membrane Transport and Rejection	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
5	Membrane Process Design (NF/RO Design)	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
6	Membrane Desalination and Reclamation	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
7	Membrane Desalination and Reclamation	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
8	Forward Osmosis and Pressure Retarded Osmosis	1, 2, 3		In-person	Lecture & Tutorial
9	Electrodialysis & Membrane Distillation	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
10	Membrane Distillation & Membrane Fouling	1, 2, 3, 4, 5		In-person	Lecture & Tutorial

Week or Session	Topics or Themes	ILO	Readings	Delivery Mode	Activities
11	Membrane Fouling	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
12	Membrane Bioreactor	1, 2, 3, 4, 5		In-person	Lecture & Tutorial
13	Membrane Bioreactor	1, 2, 3, 4, 5		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	Team/Individual	Rubrics	Level of Understanding
1	Summative Assessment (EXAM): Final exam(Final Examination)	1,2,3,4,5	ENE SLOs (2018) a, b, c	60	Individual	Holistic	Relational
2	Continuous Assessment (CA): Test/Quiz(CA1: Quiz 1)	1,2,3	ENE SLOs (2018) a, b, c	20	Individual	Analytic	Multistructural
3	Continuous Assessment (CA): Test/Quiz(CA2: Quiz 2)	1,2,3,4,5	ENE SLOs (2018) a, b, c	20	Individual	Analytic	Multistructural

Description of Assessment Components (if applicable)

<p>EAB Graduate Attributes</p> <p>"Engineering Knowledge Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems."</p> <p>"Problem Analysis Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences."</p> <p>"Design / Development of Solutions Design solutions for complex engineering problems and design systems, components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations."</p> <p>"Investigation Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions."</p> <p>"Modern Tool Usage Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations."</p> <p>"The Engineer and Society Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice."</p> <p>"Environment and Sustainability Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development."</p> <p>"Ethics Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice."</p> <p>"Individual and Team Work Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary</p>
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settings."

"Communication

Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions."

"Project Management and Finance

Demonstrate knowledge and understanding of the engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments."

"Life-long Learning

Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change."

Formative Feedback

For CA1 and CA2, the questions and solutions will be discussed with you right after the quiz. You will be informed of the median grade and individual grade will be uploaded in NTULearn.

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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