EN4102 Membrane Water Reclamation Technology

Academic Year	2023-24	Semester	2
Course Coordinator			
Course Type	Major Prescribed Elective		
Pre-requisites	Year 3 standing		
AU	3		
Grading	Letter Grading		
Contact Hours	39 (Lecture: 26 hours; Tutorial: 13 hours)		
Proposal Date	12 September 2023		

Course Aims

This course aims to develop your understanding of membrane technology applied in water reclamation process. You will be familiar with the basic design concepts and able to technically manage a membrane-based water reclamation plant.

Intended Learning Outcomes (ILO)

By the end of this course, student will be able to:

1. Discuss the classifications, working principles, and applications of various membrane technologies.

2. Analyse the main factors (feed type, pressure, electrical potential etc.) determining separation performance and energy consumption.

3. Analyse product quality and quantity (rejection and recovery).

4. Relate various membrane plant designs to their advantages and limitations.

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**

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. CA1: Quiz 1	1, 2, 3	ENE SLOs (2018) a, b, c	20%	Individual	N.A.
2. CA2: Quiz 2	1, 2, 3, 4, 5	ENE SLOs (2018) a, b, c	20%	Individual	N.A.
3. Final Examination	1, 2, 3, 4, 5	ENE SLOs (2018) a, b, c	60%	Individual	N.A.
Total			**100%**		

EAB Graduate Attributes[1]

a)	**Engineering Knowledge** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
b)	**Problem Analysis** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c)	**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.
d)	**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.
e)	**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.
f)	**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.
g)	**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.

[1] *Reference: EAB Accreditation Manual*

h)	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i)	**Individual and Team Work** Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j)	**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.
k)	**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.
l)	**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.

Learning & Teaching Approach

Approach	How does this approach support students 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.

Readings & References

1. Mulder, M., 'Basic Principles of Membrane Technology', Springer, 1996.

2. Baker, Richard W., 'Membrane Technology and Applications', Wiley, 2012.

Course Policy & Student Responsibility

(1) 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.

(2) 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.

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 recognise 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. 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 If you are uncertain about the definitions of any of these terms, you should refer to the Academic Integrity Handbook for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office	Phone	Email

Planned Weekly Schedule

Week	Topic	Course ILO	Readings/Activities
1	Introduction to Membrane Technology	1, 2, 3	Lecture & Tutorial
2	Membrane Materials and Synthesis	1, 2, 3	Lecture & Tutorial
3	Membrane Properties and Characterisation	1, 2, 3	Lecture & Tutorial
4	Membrane Transport and Rejection	1, 2, 3, 4, 5	Lecture & Tutorial
5	Membrane Process Design (NF/RO Design)	1, 2, 3, 4, 5	Lecture & Tutorial
6	Membrane Desalination and Reclamation	1, 2, 3, 4, 5	Lecture & Tutorial
7	Membrane Desalination and Reclamation	1, 2, 3, 4, 5	Lecture & Tutorial
8	Forward Osmosis and Pressure Retarded Osmosis	1, 2, 3	Lecture & Tutorial
9	Electrodialysis & Membrane Distillation	1, 2, 3, 4,5	Lecture & Tutorial
10	Membrane Distillation & Membrane Fouling	1, 2, 3, 4, 5	Lecture & Tutorial
11	Membrane Fouling	1, 2, 3, 4, 5	Lecture & Tutorial
12	Membrane Bioreactor	1, 2, 3, 4, 5	Lecture & Tutorial
13	Membrane Bioreactor	1, 2, 3, 4, 5	Lecture & Tutorial