

**ACADEMIC AFFAIRS OFFICE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE**

No. Acd./253/IAPC-102

Dated: May 13, 2021

Head, Department of Hydrology

The IAPC in its 102nd meeting held on 21.04.2021 vide Item No. 102.2.7 considered and approved the proposal of Department of Hydrology to introduce new Programme Elective Course (PEC) i.e., HYN-577: Desalination and Cleaner Water Production with Membrane Technologies with minor modifications.

The modified syllabus is attached as **Appendix-A**.

Reeti

Assistant Registrar (Curriculum)

Encl: as above

Copy to (through e mail):-

1. All faculty
2. Head of all Departments/ Centres
3. Dean, Academic Affairs
4. Associate Dean of Academic Affairs (Curriculum)
5. Channel I/ Acad portal/ Academic webpage of iitr.ac.in

INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

NAME OF DEPARTMENT/CENTRE: Department of Hydrology

1. **Subject Code:** HYN-577 **Course Title:** Desalination and Cleaner Water Production with Membrane Technologies
2. **Contact Hours:** **L:** 3 **T:** 1 **P:** 0
3. **Examination Duration (Hrs.):** **Theory:** 3 **Practical:** 0
4. **Relative Weightage:** **CWS:** 20-35 **PRS:** 0 **MTE:** 20-30 **ETE:** 40-50 **PRE:** 0
5. **Credits:** 4 6. **Semester:** Both 7. **Subject Area:** PEC
8. **Pre-requisite:** Nil
9. **Objective:** This course aims to introduce and disseminate the knowledge about various desalination technologies and membrane science for producing clean water.

10. Details of the Course

S.No.	Contents	Contact hours
1.	Course introduction: Growing needs, and water stress; alternate water resources - wastewater and seawater purification; definition of sustainability; key areas of development for sustainable desalination; introduction of membrane science, engineering and applications	3
2.	Membrane processes, principles of operation and classifications: Spontaneous and forced separation; types of separation processes; introduction to membrane; membrane processes; membrane classification-structure, configuration, materials, surface charge; membrane separations-mode of operation; membrane technologies- dialysis, electrodialysis, pervaporation, gas permeation, liquid membranes, membrane distillation, osmotic distillation, forward osmosis.	9
3.	Membrane fabrication: Membrane materials and structures; membrane fabrication methods – phase inversion, stretching, lithography, anodic oxidation template leaching, ion-exchange, electrospinning, electrospray.	6
4.	Membrane characterization: Pore properties- size and distribution; porosity; surface roughness; surface morphology study with scanning electron microscopy; measurement of liquid spreading with contact angle- hydrophilic, hydrophobic, omniphobic; surface energy of membranes.	6
5.	Membrane fouling: Definition; types of fouling- particulate, scaling, biofouling, organic fouling (natural and algal organic matters), reversible and irreversible; red tides- harmful algal blooms; fouling mechanism and identification; strategies to monitor the fouling potential of membrane; pre-treatment options to mitigate fouling; membrane surface modifications; membrane autopsy.	4
6.	Renewable energy powered desalination: Classification of desalination processes; introduction to solar desalination; potential processes for solar desalination; gain output ratio; performance ratio; environmental impacts of desalination, case studies.	4
7.	Economics of desalination processes: Brackish water desalination by reverse osmosis and nanofiltration; capital cost; membrane replacement; spare	2

	parts/operational materials; manpower; chemicals; energy; concentrate disposal.	
8.	Introduction to emerging membrane distillation technology: Membrane distillation and its configurations; transfer process; ideal membrane characteristics; types of membranes; liquid entry pressure; limitations-wetting, scaling, fouling; advantages of membrane distillation.	3
9.	Cleaner water production/applications for industry, drinking water: Different treatment processes and their combination; produced water quality; selection of membrane technologies; target applications; relevant case studies.	5
Total		42

11. List of Experiments:

- Demonstration of various membranes-based water treatment processes.
- Experiments on membrane treatment processes for desalination and wastewater treatment.
- Investigation of membrane fouling and mitigation strategies.

12. Suggested Books:

S.No.	Name of Authors/Book/Publisher	Year of Publication / Reprint
1.	Caetano, A., de Pinho, M.N., Drioli, E., Muntau, H. (Eds.), Membrane Technology: Applications to Industrial Wastewater Treatment. ISBN-13: 978-0792332091, Publisher: Springer (30 November 1994)	2012
2.	Saji, Viswanathan S., Meroufel, Abdelkadar A., Sorour, Ahmad (Eds.), Corrosion and Fouling Control in Desalination Industry, ISBN 978-3-030-34284-5	2020
3.	Richard W. Baker, Membrane technology and applications. US: Willey. ISBN: 0 07 135440 9	2012
4.	Kang-Jia Lu & Tai-Shung Chung, Membrane distillation: membranes, hybrid systems and pilot studies. CRC Press, US: Taylor & Francis. ISBN: 9780429287879. 1 Edition https://doi.org/10.1201/9780429287879	2019
5.	Nikolay V., Desalination Engineering: Planning and Design. McGraw-Hill, 1 Edition	2012
6.	Lior N., Advances in Water Desalination. US: Wiley, 1 Edition	2013
7.	Marcel Mulder, Basic Principles of Membrane Technology. Netherlands: Kluwer Academic Publishers, ISBN-13: 978-0-7923-4248-9, DOI: 10.1007/978-94-009-1766-8, 2 Edition	1996
8.	W. S. Winston Ho, K.K. Sirkar, Membrane Handbook, Publisher: Van Nostrand Reinhold, New York, ISBN: 978-1-4613-6575-4, DOI: 10.1007/978-1-4615-3548-5	1992
9.	K. Scott, Handbook of Industrial Membranes, Publisher: Elsevier Science & Technology, ISBN: 9781856172332, 2 Edition	1995