MNE6135: TWO-PHASE FLOW AND BOILING HEAT TRANSFER

Effective Term
Semester A 2026/27

Part I Course Overview

Course Title
Two-phase Flow and Boiling Heat Transfer

Subject Code
MNE - Mechanical Engineering
Course Number
6135

Academic Unit
Mechanical Engineering (MNE)

College/School
College of Engineering (EG)

Course Duration
One Semester

Credit Units
3

Level
P5, P6 - Postgraduate Degree

Medium of Instruction
English

Medium of Assessment
English

Prerequisites
Nil

Precursors
Nil

Equivalent Courses
Nil

Exclusive Courses
Nil

Part II Course Details

Abstract

Two-phase flow and boiling heat transfer is of significant interest and fundamental importance for scientific research. Through the combination of latent heat of phase-change and enhanced convective heat transport, boiling heat transfer demonstrates extremely high capability for heat transfer and can have many industrial applications with high heat intensity including nuclear power plants. Convective boiling heat transfer will create two-phase flow of vapour and liquid, which presents much more complicate transport mechanism of mass, momentum, and heat. This course will first present fundamentals of boiling heat transfer and two-phase flow including nucleation theory, bubble dynamics, interfacial instability, and quality and void Fraction. Subsequently, various modes of boiling heat transfer including nucleate pool boiling, nucleate flow boiling and forced convective evaporation, critical heat flux, and post-CHF heat transfer will be lectured. The second half of the course will focus on conservation equations of two-phase flow, constitutive equations, steady-state and dynamics of two-phase flow.

Course Intended Learning Outcomes (CILOs)

	CILOs	Weighting (if app.)	DEC-A1	DEC-A2	DEC-A3
1	Describe the basic concepts and conservation equations of two-phase flow.		x		
2	Explain the principles of various modes of boiling heat transfer, steady two-phase flow, and dynamics of twophase flow.		x	x	
3	Identify the needs for suitable mode of boiling heat transfer and two-phase flow for various industrial applications.			x	
4	Apply the concepts, principles, and methods learned for the design and development of boiling heat transfer and/or two-phase flow for different applications.			x	x

A1: Attitude
Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability
Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments
Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

	LTAs	Brief Description	CILO No.	Hours/week (if applicable)
1	Lecture	To take place in the classroom. The main teaching activities will be in the form of lectures, which will be given related to the topics in the keyword syllabus.	1, 2, 3, 4	2 hrs/week

2	Tutorial	To take place in the classroom. The tutorials are problem-solving and Q&A sessions for strengthening students' understanding of the contents of the lectures. The course project will also help in the learning practice.	1, 2, 3, 4	1 hr/week. The tutorial may mix with lecture to illustrate the concept/ theory presented in the lecture.

Assessment Tasks / Activities (ATs)

	ATs	CILO No.	Weighting (%)	Remarks ("-" for nil entry)	Allow Use of GenAI?
1	Test/Assignments	1, 2	30		
2	Mini-projects	3, 4	20		

Continuous Assessment (%)

50

Examination (%)

50

Examination Duration (Hours)

2

Additional Information for ATs

For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

Assessment Rubrics (AR)

Assessment Task

Test/Assignments

Criterion

Ability to understand the basic concepts related to robotics.

Excellent

(A+, A, A-) High

Good

(B+, B, B-) Significant

Fair

(C+, C, C-) Moderate

Marginal

(D) Basic

Failure

(F) Not even reaching marginal levels

Assessment Task
Mini-projects

Criterion
Ability to understand and explain in details and apply the learned knowledge to the analysis and design of robotic systems for practical applications.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Assessment Task
Examination

Criterion
Ability of in-depth understanding of the key concepts, principles, methods, and applications of robotic systems.

Excellent
(A+, A, A-) High

Good
(B+, B, B-) Significant

Fair
(C+, C, C-) Moderate

Marginal
(D) Basic

Failure
(F) Not even reaching marginal levels

Additional Information for AR

Note: For a student to pass the course, at least 30% of the maximum mark for both coursework and examination should be obtained.

Part III Other Information

Keyword Syllabus

- Two-phase flow dynamics
- Two-phase heat transfer

- Supercritical fluid flow and heat transfer
- Nanofluids flow and heat transfer

Reading List

Compulsory Readings

	Title
1	Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt. Fundamentals of Heat and Mass Transfer. 7th edition. New York, NY: John Wiley and Sons, 2011. ISBN: 978-0-470-50197-9.
2	Collier, J. G., and J. R. Thome. Convective Boiling and Condensation. 3rd ed. New York, NY: Oxford University Press, 1996. ISBN: 9780198562962.

Additional Readings

	Title
1	Todreas, N. E., and Kazimi, M. S. Nuclear Systems I: Thermal Hydraulic Fundamentals. Taylor & Francis Group, LLC, Second Edition, 2011.
2	Bernard Zappoli, Daniel Beysens, and Yves Garrabos. Heat Transfers and Related Effects in Supercritical Fluids. Springer, 2015. ISBN: 9789401791878 (ebook).
3	Sarit K. Das, Stephen U. S. Choi, Wenhua Yu, T. Pradeep. Nanofluids: Science and Technology. John Wiley & Sons, Inc., 2008. Online ISBN: 9780470180693.
4	Students are encouraged to find out related publications to widen their knowledge in the subjects.