GANPAT UNIVERSITY

FACULTY OF DIPLOMA ENGINEERING

Programme	Diploma in Petrochemical/Chemical Engineering				
Semester	III		Version	1.0.0.0	
Effective from Academic Year	2026-27		Effective for the batch Admitted in		JULY 2025
Course code	1PCT3103	Course Name	Heat Transfer Operation		

I.TEACHING-LEARNING AND ASSESSMENT SCHEME

Course Type	Course Code	Learning Scheme						Assessment Scheme										
		Actual Contact Hrs./Week			SLH	NLH	Credits	Theory				Practical				Based on SL		Total Marks
		CL	TL	LL				FA-TH	SA-TH	TOTAL		FA-PR	SA-PR	TOTAL		SLA		
								MAX	MAX	MAX	MIN	MAX	MAX	MAX	MIN	MAX	MIN	
DSC	1PCT3103	3	-	2	3	8	4	40	60	100	40	30	20	50	20	20	8	170

Abbreviation:	**CL-** Classroom Learning	**TL -** Tutorial Learning	**LL -** Laboratory Learning
	SLH - Self Learning Hours	**NLH -** Notional Learning Hours	**SLA -** Self Learning Assessment
	FA - Formative Assessment (Term work +Mid Sem Exam + Attendance)		**SA -** Summative Assessment

II. PRE-REQUISITES

Basic knowledge of Applied science

III. INDUSTRY / EMPLOYER EXPECTED OUTCOMES

Identify common operational problems and supervise the maintenance of various heat transfer equipment to conserve thermal energy in the chemical industry.

IV. COURSE LEARNING OUTCOMES

At the end of the course, students will be able to achieve the following course learning outcomes:

CO1: Explain the modes of heat transfer and relate them to industrial applications.

CO2: Derive equations of steady state heat transfer through wall, cylinder and sphere by conduction.

CO3: Analyze heat transfer by convection and use the concept of radiation for heat transfer.

CO4: Select appropriate heat exchanger equipment for specific application.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT:

Name of Unit	Theory Learning outcomes (TLO's) aligned to CO's	Learning Content mapped with Theory Learning outcomes (TLO's) & CO's	Marks	Hours
Unit-1 Fundamental of Heat Transfer	**TLO 1.1** Explain the basic heat transfer phenomena occurring in engineering systems. **TLO 1.2** Define and classify modes of heat transfer **TLO 1.3** Differentiate between steady-state and unsteady-state heat transfer with examples. **TLO 1.4** Explain the importance and applications of heat transfer in industrial processes.	**1.1** Basic Heat Transfer Phenomena **1.2** Modes of Heat Transfer: - Conduction, Convection, Radiation **1.3** Concept- steady state and unsteady state heat transfer **1.4** General Heat Transfer Application	**06**	**04**

Unit-2 **Heat Transfer by Conduction**	**TLO 2.1** Explain the mechanism of heat conduction in solids. **TLO 2.2** State and explain Fourier's law of heat conduction. **TLO 2.3** Describe thermal conductivity and explain its variation with temperature. **TLO 2.4** Explain the concept of thermal resistance in heat conduction. **TLO 2.5** Derive equations for steady-state heat conduction through plane and composite walls **TLO 2.6** Explain the concept and significance of overall heat transfer coefficient. **TLO 2.7** Derive equations of steady state heat transfer through wall, cylinder and sphere **TLO 2.8** Explain the use of traditional insulating materials such as mud, lime, cow dung, and natural fibers in Indian construction practices. **TLO 2.9** Explain the concept of critical radius of insulation for cylinders and spheres. **TLO 2.10** Apply conduction equations to solve numerical problems.	**2.1** Basic Concept-Heat Transfer by Conduction **2.2** Fourier's law of heat conduction **2.3** Thermal conductivity of materials and its variation with Temperature. **2.4** Thermal resistance **2.5** Heat Conduction through Plane and composite wall **2.6** The Overall heat transfer co-efficient **2.7** Heat Conduction through hollow and composite cylinders **2.8** Traditional Insulation Techniques (IKS) **2.9** Critical thickness of insulation for cylinder and sphere. **2.10** Numerical problems based on above topics.	**18**	**15**
Unit-3 **Heat Transfer by Convection**	**TLO 3.1** Explain the principle of heat transfer by convection **TLO 3.2** Distinguish between natural and forced convection. **TLO 3.3** Define heat flux, average temperature, and mean fluid temperature. **TLO 3.4** State and explain Newton's law of convection. **TLO 3.5** Define and explain the significance of Nusselt, Prandtl, Grashof, Graetz, and Froude numbers. **TLO 3.6** Apply convection principles to solve simple numerical problems.	**3.1** Concept-Heat Transfer by Convection **3.2** Types of convection Heat transfer by forced convection in laminar and turbulent flow **3.3** Heat flux, average temperature, average temp. of fluid. **3.4** Newton's law of convection **3.5** Dimensionless numbers and their significance in heat transfer: Graetz number, Prandle number, Nusselt number, Froude number and Grashof number **3.6** Simple Numerical problem based on convection	**10**	**07**

Unit-4 **Heat Transfer by Radiation**	**TLO 4.1** Explain the mechanism of heat transfer by radiation and define terms regarding radiation. **TLO 4.2** Describe emission properties of surfaces. **TLO 4.3** Explain absorptivity, reflectivity, and transmissivity. **TLO 4.4** Explain the concept of black body and gray body. **TLO 4.5** State and explain Kirchhoff's, Planck's, Stefan–Boltzmann, and Wien's laws. **TLO 4.6** Apply radiation laws to solve numerical problems.	**4.1** Concept-Heat Transfer by Radiation **4.2** Surface Emission Properties **4.3** Absorptivity, reflectivity and transmissivity **4.4** Concept of black body **4.5** Explanation of Kirchoff's law, Plank's law, Stefan boltzman law, Wein's law. **4.6** Simple Numerical problem based on above topics.	**12**	**08**
Unit-5 **Heat transfer Equipments**	**TLO 5.1** Describe TEMA standards **TLO 5.2** Identify heat transfer equipment used in process industries. **TLO 5.3** Classify heat exchanger **TLO 5.4** Describe Double pipe heat exchanger **TLO 5.5** Differentiate between parallel flow and counter flow heat exchangers. **TLO 5.6** Explain the construction and working of shell and tube heat exchanger. **TLO 5.7** Explain the construction and working of plate type heat exchanger. **TLO 5.8** Explain the concept and significance of logarithmic mean temperature difference. **TLO 5.9** Classify different types of evaporators. **TLO 5.10** Explain evaporator capacity and economy and their importance.	**5.1** Introduction to TEMA standards **5.2** Heat transfer equipments used in process industries **5.3** Types of heat exchanger by flow and by function **5.4** Double pipe heat exchanger **5.5** counter flow, co – current flow **5.6** Shell and tube heat exchanger. **5.7** Plate type heat exchanger. **5.8** Concept-Logarithmic Mean Temperature Difference(LMTD) **5.9** Types of evaporators **5.10** Evaporator capacity and economy	**14**	**11**

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL			
Sr. No.	**Practical/Laboratory Learning Outcome (LLO)**	**Practical Titles**	**Relevant Cos**
1	**LLO 1.1** Understand heat conduction in metals and calculate thermal conductivity using experimental data.	Determine the thermal conductivity of Metal Rod.	CO2
2	**LLO 2.1** Learn to analyse heat transfer through multi-layer materials and determine effective thermal conductivity.	Determine the thermal conductivity of composite wall	CO2
3	**LLO 3.1** Identify the effect of insulation thickness and geometry on heat loss; calculate critical radius for minimum heat loss.	Determine critical radius of insulating material	CO2

4	**LLO 4.1** Calculate rate of heat transfer by measuring voltage and current. And Calculate heat loss	Determination of the heat transfer coefficient in natural convection.	CO3
5	**LLO 5.1** Calculate emissivity using Stefan-Boltzmann equation.	Determine the emissivity using Stefan Boltzmann apparatus	CO4
6	**LLO 6.1** Evaluate heat transfer performance of a shell and tube exchanger and calculate overall heat transfer coefficient experimentally.	Determination of overall heat transfer co-efficient in shell & tube heat exchanger	CO2 CO3 CO4
7	**LLO 7.1** Compare heat transfer effectiveness of parallel vs counter-flow arrangements and determine corresponding heat transfer coefficients.	Determination of overall H.T. co-efficient in parallel flow and counter flow	CO2 CO3 CO4
8	**LLO 8.1** Understand working principles, design features, and performance differences of various evaporators used in industry.	Study and compare different types of Evaporators	CO4

VII. SUGGESTED MICRO PROJECT / ASSIGNMENTS / ACTIVITIES FOR SELF LEARNING / SKILL DEVELOPMENT (SELF LEARNING)

- Prepare a model of Double pipe heat exchanger, Shell and tube heat exchanger.
- Visit any nearby industry/Plant and Prepare a report on heat transfer equipment used in the industry/Plant.

VIII. LIST OF INSTRUMENTS / EQUIPMENT / TRAINER BOARD	
1	Thermal conductivity metal rod apparatus
2	Thermal conductivity composite wall apparatus
3	Stefan Boltzmann apparatus
4	Natural Convection apparatus
5	Shell and tube heat exchanger
6	Parallel flow and counter flow heat exchanger setup
7	Thermal conductivity of insulating Powder apparatus
8	Stopwatch

IX. LIST OF REFERENCE BOOKS

Sr.No.	Title	Author	Publication
1	Engineering heat transfer	Gupta & Prakash	New Chand & Brothers, New Delhi, 1999 (Seventh Edition)
2	Process heat transfer	D.Q.Kern	Tata McGraw Hill Publication, New Delhi, (Reprint 2008)
3	Introduction Chemical Engineering	Badger W. L. and Banchero J. T	Tata McGraw Hill
4	Unit Operations of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004 (Seventh Edition)
5	Introduction to chemical engineering	Ghosal Salil k.	Tata McGraw Hill Publication, New Delhi, (Reprint 2006)
6	Heat and mass transfer operation	Domkundwar Arora	Dhanpatrai and co(p) ltd. Delhi ISBN-10:8177000292

X. LINK OF LEARNING WEB RESOURCE	
1	https://digimat.in/nptel/courses/video/103101137/L01.html
2	https://digimat.in/nptel/courses/video/103105140/L01.html
3	http://acl.digimat.in/nptel/courses/video/103103031/L36.html
4	https://www.digimat.in/nptel/courses/video/103101137/L58.html
5	https://www.digimat.in/nptel/courses/video/103101137/L57.html
6	https://www.youtube.com/watch?v=qa-PQOjS3zA
7	www.unitoperation.com

XI. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE

Unit	Unit Title	Aligned Cos	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	Fundamental of Heat Transfer	CO1	4	2	3	1	6
2	Heat Transfer by Conduction	CO2	15	5	7	6	18
3	Heat Transfer by Convection	CO3	7	4	4	2	10
4	Heat Transfer by Radiation	CO4	8	4	6	2	12
5	Heat transfer Equipments	CO4	11	5	7	2	14
Grand Total			45	20	27	13	60

XII. COs AND POs AND PSOs MAPPING

Course outcome (COs)	Programme Outcomes (POs)							Programme Specific Outcomes (PSOs)		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	2	2	1
CO2	3	3	2	1	1	1	1	3	1	1
CO3	3	3	2	2	1	1	1	3	2	1
CO4	3	2	2	2	1	1	1	2	1	1

Legends: -*3- High 2-Moderate/Medium 1-Slight/Low 0-None*