Gyanmanjari
Innovative University

Subject: Process Heat Transfer – DETCH14207

Type of course: Major

Prerequisite: Basic knowledge of conduction, convection and radiation.

Rationale: Process heat transfer provides the foundation for understanding and controlling the transfer of heat between different phases in chemical processes, enabling engineers to design efficient, effective, and high-quality operations.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
CI	T	P	C	Theory Marks		Practical Marks		CA	
				ESE	MSE	V	P	ALA	
3	0	2	4	60	30	10	20	30	150

Legends: CI - Class Room Instructions; T – Tutorial; P - Practical; C – Credit; ESE - End Semester Examination; MSE- Mid Semester Examination; V – Viva; CA - Continuous Assessment; ALA- Active Learning Activities.

Course Content:

	Course content	Hrs	Weightage
1	**Unit Systems :** Explain importance of heat transfer, Define different unit systems, Explain the usage of various heat transfer units, Convert units among different systems **Heat transfer and its applications:** Nature of heat flow, Conduction, Convection, Natural and forced convection, Radiation.	10	20%
2	**Heat Transfer by Conduction:** Basic law of Conduction: Thermal Conductivity, Steady-State Conduction: Compound resistances in series, Heat flow	10	25%

Sr.	Content	Marks	%
	through a cylinder Unsteady-state conduction: One dimensional heat flow with constant surface temperature, Heat flow with variable surface temperature, total heat transfer, semi-infinite solid.		
3	**Principles of Heat Flow in Fluids** Typical Heat-Exchange Equipment: Countercurrent and parallel flows Energy Balances: Enthalpy balances in heat exchangers, Enthalpy balances in total condensers Heat Flux and Heat-Transfer Coefficient: average temperature of fluid stream, Overall Heat-Transfer Coefficient, Integration over total surface; logarithmic mean temperature difference, variable overall coefficient. Individual Heat-Transfer Coefficients: calculation of overall coefficients from individual coefficients, Resistance from of overall coefficient, Fouling factors, Special cases of the overall coefficient, classification of individual heat-transfer coefficients, magnitude of heat-transfer coefficients.	15	30%
4.	**Heat Transfer to Fluids Without Phase Changes** Boundary Layers: Regimes of heat transfer, Thermal boundary layer, Prandtl number Heat Transfer By Forced Convection In Laminar Flow: Laminar flow heat transfer to flat plate, Laminar flow heat transfer in tubes, Graetz and Peclet numbers, Exit temperature in plug flow, Fully developed flow, correction for heating or cooling, Effect of inserts on heat transfer, Heat transfer to non-newtonian liquids in laminar flow.	10	25%

Continuous Assessment:

Sr. No.	Active Learning Activities	Marks
1.	**Day to day application:** Students have to list out different modes of heat transfer with examples from day to day life. Students have to upload a brief report on GMIU web portal.	10
2.	**Problem solving:** Students will be given a problem based on Heat transfer by the three modes by the faculty. Students have to solve them and upload on GMIU web portal.	10
3.	**Case Study:** Students will be given a case study from industry with a problem in heat transfer. Students need to search for probable solution to increase the heat transfer rate. Upload a report on GMIU web portal.	10
	Total	30
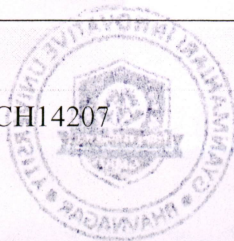
LIST OF PRACTICALS:

Sr. No.	Practical	Unit	Hours
1	Determine the thermal conductivity of Metal Rod	2	2
2	Determine the thermal conductivity of Metallic sphere	2	2
3	Determine the thermal conductivity of composite wall	2	2
4	Determine critical radius of insulating material - 1	2	2
5	Determine critical radius of insulating material - 2	2	2
6	Determine the specific heat of Air	3	4
7	Determine the overall heat transfer co-efficient in Agitated vessel-1	3	4
8	Determine the overall heat transfer co-efficient in Agitated vessel-2	3	4
9	Determine the overall heat transfer co-efficient for air to water heat exchanger-1	4	4
10	Determine the overall heat transfer co-efficient for air to water heat exchanger-2	4	4
Total			30

Suggested Specification table with Marks (Theory): 60

Distribution of Theory Marks (Revised Bloom's Taxonomy)						
Level	Remembrance (R)	Understanding (U)	Application (A)	Analyze (N)	Evaluate (E)	Create (C)
Weightage	20%	20%	25%	15%	20%	00

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Course Outcome:

After learning the course the students should be able to:	
CO1	Classify different modes of heat transfer.
CO2	Derive equations of steady state heat transfer through wall, cylinder and sphere.
CO3	Explain various types of heat exchangers.
CO4	Calculate various dimensionless numbers used in convection

Instructional Method:

The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

From the content 10% topics are suggested for flipped mode instruction.

The internal evaluation will be done on the basis of Active Learning Assignment.

Practical/Viva examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

Reference Books:

[1] Unit Operations of Chemical Engineering, Warren L. McCabe, Julian C. Smith, McGraw Hill Publication, New York 2004 (Seventh Edition).
[2] Introduction to Chemical Engineering, L. Badger, Julius T. Banchero, McGraw Hill Publication, New York 2004 (Seventh Edition).
[3] Engineering Heat Transfer, Gupta & Prakash, Nem Chand & Brothers, New Delhi, 1999 (Seventh Edition).
[4] Process Heat Transfer, D.Q.Kern, Tata McGraw Hill Publication, New Delhi, (Reprint 2008).
[5] Unit Operation-II, K.A. Gavhane, Nirali Prakashan, Pune 2009
[6] Introduction to Chemical Engineering, Salil K. Ghosal, Tata McGraw Hill Publication.