TEE-907 Technologies for Enhanced Heat Transfer

Objectives

1. The objectives of this course are:
   a. To understand the fundamentals of enhanced heat transfer
   b. To discuss main heat transfer enhancement techniques
   c. To develop new designs for enhanced heat transfer applications
   d. To apply heat transfer enhancement techniques into thermal heat storage system
   e. To enable students to identify the optimal solutions to any enhanced heat transfer application, in any sector where heat transfer is involved.

Course Contents

2. Contents with suggested contact hours

No.	Topics	Contact Hours
a.	**Introduction to Enhanced Heat Transfer** • Enhancement Techniques • Benefits of Enhancement • Commercial Applications of Enhanced Surfaces • Definition of Heat Transfer Area • Potential for Enhancement	3
b.	**Heat Transfer Fundamentals** • Heat Exchanger Design Theory • Fin Efficiency • Heat Transfer Coefficients and Friction Factors • Correction for Variation of Fluid Properties • Reynold Analogy • Fouling of Heat Transfer Surfaces	5
c.	**Performance Evaluation Criteria for Single Phase Flow**	5

	• Performance Evaluation Criteria (PEC) • PEC for Heat Exchangers • PEC for Single Phase Flow • Thermal Resistance on Both Sides • Heat Exchanger Effectiveness • Effect of Reduced Exchanger Flow Rate • Flow Normal to Finned Tube Banks • Exergy Based PEC Analysis	
d.	**Performance Evaluation Criteria for Two Phase Flow** • Operating Characteristics of Two Phase Heat Exchangers • Enhancement in Two Phase Heat Exchange Systems • PEC for Two Phase Heat Exchange Systems • PEC Calculation Method	5
e.	**Plate and Fin Extended Surfaces** • Offset Strip Fin • Louver Fin • Convex Louver Fin • Wavy Fin • Three Dimensional Corrugated Fins • Perforated Fin • Pin Fins and Wire Mesh • Vortex Generators • Metal Foam Fin • Plain Fin • Entrance Length Effects	5
f.	**Externally Finned Tubes** • Geometric Parameters and the Reynolds Number • Plain Plate Fins On Round Tubes	5

	• Plain Individually Finned Tubes • Enhanced Plate Fin Geometries with Round Tubes • Enhances Circular Fin Geometries • Oval and Flat Tube Geometries • Row Effects- Staggered and Inline Layouts • Heat Transfer Coefficient distribution • Performance Comparison of different Geometries	
g.	**Insert Devices and Internally Finned Tubes** • Twisted Tape Insert • Segmented Twisted Tape Insert • Displaces Enhanced Devices • Wire Coil Inserts • Extended Surface Inserts • Tangential Injection Devices • Internally Finned Tubes • Spirally Fluted Tubes • Advanced Internal Fin Geometries • Finned Annuli	5
h.	**Fouling on Enhanced Surfaces** • Fouling Fundamentals • Fouling of Gases on Finned Surfaces • Shell-Side Fouling of Liquids • Fouling of Liquids in Internally Finned Tubes • Liquid Fouling in Rough Tubes • Liquid Fouling in Plate Fin Geometry • Correlations for Fouling in Rough Tubes • Fouling in Plate Heat Exchangers	4
i.	**Enhancement Using Electric Fields and Additives for Gases and Liquids** • Electrode Design and Placement	4

	• Single Phase Fluids • Condensation and Boling • Additives for Single Phase Liquids • Additives for Single Phase Gases • Additives for Boiling • Additives for Condensation and Absorption	
j.	**Electronic Cooling Heat Transfer** • Component Thermal Resistances • Limits on Direct Heat Removal with Air-Cooling • Second Generation IndHR Devices for Heat Removal at Hot Surface • Discussion on Advanced Heat Removal Concepts • Remote Heat Exchangers for IndHR • System Performance for IndHR System	4
		45

Outcomes

3. By the end of this course students will be able to:
   a. To understand the theory behind the heat transfer enhancement
   b. Identify and explain the working principles of fins of different shapes
   c. Identify and explain the relative costs and sustainability of each technology
   d. Evaluate the advantages and disadvantages of different enhanced heat transfer techniques applied in a practical situation and compare the engineering problems in the real world
   e. Describe sensible heat storage systems used for diurnal and inter-seasonal thermal energy storage
   f. Evaluate the potential of phase change materials and chemical reaction systems for thermal energy storage
   g. Compare the practicality of energy storage systems given the available resources within the local context

h. Evaluate the potential of energy storage in the local context from given case studies

f. Details of lab work, workshops practice (if applicable).

4. **Recommended Reading (including Textbooks and Reference books).**

S. No.	Title	Author(s)	Remarks
a.	Principles of Enhanced Heat Transfer, Taylor & Francis, New York, 2005	Ralph L. Webb Nae-Hyun Kim	Text Book
b.	Advances in Heat Transfer Enhancement, Springer Nature, 2016, Switzerland	Sujoy Kumar Saha, Manvendra Tiwari, Bengt Sunden, Zan Wu	Reference Book
c.	Heat Transfer Enhancement with Nanofluids, CRC Press, 2015	Vincenzo Bianco, Oronzio Manca, Sergio Nardini, Kambiz Vafai	Reference Book
d.	Plate Heat Exchangers: Design, Applications and Performance, WIT Press, 2007, USA	L. Wang, B. Sunden, R. M. Manlik	Reference Book