LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING & TECHNOLOGY

Department of Chemical Engineering (708)

Bachelor of Engineering (B.E.) – Semester – IV

Course Code:	**017083403**
Course Name:	**Heat Transfer**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Thermodynamics

Teaching Scheme				
Lecture (L)	**Tutorial (T)**	**Practical (P)**	**Credit**	**Total Hours**
5	**0**	**2**	**6**	**50**

Syllabus

Unit No.	Topic	Prerequisite Topic	Successive Topic	Teaching Hours
01	**Introduction to Three Modes of Heat Transfer**			**3 (6%)**
	1.1 Introduction to Heat Transfer	Zeroth Law of Thermodynamics (017082201-Unit-3)	Introduction to Energy Transport (017083501-Unit-5) Shell Energy Balance and Temperature Distribution in Solids (017083501-Unit-6)	
	1.2 Three Modes of Heat Transfer			
	1.3 General Laws of Heat Transfer			
02	**Conduction**			**5 (10%)**
	2.1 Fourier's Law		Temperature and Pressure Dependence of Thermal Conductivity (017083501-Unit-5.2) Fourier's Law (017083501-Unit-5.3)	
	2.2 Concept of Thermal Conductivity			
	2.3 Heat Transfer Through plane wall, Composite Wall and Cylinder		Heat Conduction Through Composite Wall (017083501-Unit-6.5) Temperature Distribution in Two Concentric Cylinders (017083501-Unit-6.4)	
	2.4 Heat Transfer Through Sphere			
	2.5 Different Types of Insulating Materials			
	2.6 Optimum Thickness of Insulation			
03	**Convection**			**5 (10%)**
	3.1 Mechanism of Convection			
	3.2 Convective Heat Transfer Coefficient			
	3.3 Types of Convection – natural convection and forced convection			
	3.4 Dimensionless Numbers Used in Heat Transfer and Their Significance			
04	**Natural Convection**			**4 (8%)**
	4.1 Dimensional Analysis	Dimensional Analysis and similarities (017083302 – Unit-6.1)	Convective Heat Transfer (017083501-Unit-7)	
	4.2 Natural Convection from Vertical and Horizontal Surfaces Under Laminar and Turbulent Conditions for Plates	1st Law of Thermodynamics (017082201-Unit-4)		
	4.3 Natural Convection from Vertical and Horizontal Surfaces Under Laminar and Turbulent Conditions for Cylinders			
05	**Forced Convection**			**4 (8%)**
	5.1 Methods for Estimation of Convection Heat Transfer Coefficient		Convective Heat Transfer (017083501-Unit-7)	
	5.2 Analogy Between Momentum and Heat Transfer			
	5.3 Reynold's Analogy			
	5.4 Prandtl Analogy			
	5.5 Colburn Equation			
06	**Radiation**			**5 (10%)**
	6.1 Concept of Radiation	Introduction to Atomic and Molecular Structure (017081101-Unit-1) Introduction to Chemical bonding (017081201-Unit-1)		
	6.2 Stefan Boltzmann's law, Kirchhoff's law			
	6.3 Wien's law, Plank's law			
	6.4 Black body, Gray body. Transmissivity, Absorptivity, Reflectivity, Emissivity of black bodies and gray bodies			
	6.5 Concept of Black body			
	6.6 Radiation Transfer Between Surfaces			
	6.7 Radiation Shields and View factor			

07	**Heat Transfer with Phase Change**			**5 (10%)**
	7.1 Boiling of Liquid			
	7.2 Pool Boiling Curve			
	7.3 Condensation of Vapor			
	7.4 Film wise and Dropwise Condensation			
	7.5 LMTD and Overall Heat Transfer Coefficient			
08	**Evaporation**			**7 (14%)**
	8.1 Principle of Evaporation			
	8.2 Performance of Tubular Evaporator – capacity and economy of an evaporator			
	8.3 Boiling Point Elevation			
	8.4 Duhring's Rule			
	8.5 Types of Evaporators – natural and forced circulation evaporator			
	8.6 Multiple Effect Evaporation			
	8.7 Vapor recompression, Thermal Recompression and Mechanical Recompression			
09	**Heat Exchange Equipment**			**6 (12%)**
	9.1 Classification of Heat Exchange Equipment		---	
	9.2 Flow Arrangement in a Heat Exchange Equipment			Counter current Cooling of Tanks (017083701-Unit-4.1)
	9.3 Individual and Overall Heat Transfer Coefficient			
	9.4 LMTD Correction Factor			
10	**Types of Heat Exchanger**			**6 (12%)**
	10.1 Shell and Tube Heat Exchanger			
	10.2 Double Pipe Heat Exchanger			
	10.3 Fouling Factor			
	10.4 Extended Surface Heat Exchangers, plate type heat exchangers, U-tube heat exchanger			Temperature Distribution in a Transverse Cooling fin of Triangular Cross-Section (017083701-Unit-4.2)
	10.5 Fin Efficiency and Fin Effectiveness			

Sr No.	Practical Title	Link to Theory Syllabus
1	To determine the thermal conductivity of a given Insulating powder.	Unit 2
2	To determine the thermal conductivity of metal rod.	Unit 2
3	To determine the thermal conductivity of lagging material, by heater input to be heat flow rate through the pipe.	Unit 2
4	To determine heat transfer co-efficient by natural convection.	Unit 4
5	To determine heat transfer co-efficient by forced convection.	Unit 5
6	To determine the emissivity of a given body.	Unit 6
7	To determine Stephan Boltzmann constant experimentally.	Unit 6
8	To determine the overall heat transfer co-efficient of shell and tube type heat exchangers.	Unit 9
9	To determine parallel and counter flow of heat exchanger with respect to heat transfer co-efficient.	Unit 9
10	To determine effects of Fin in heat transfer equipment.	Unit 10

Major Components/ Equipment	
Sr. No.	**Component/Equipment**
1	Thermal Conductivity Tester
2	Emissivity Measuring Instrument
3	shell and tube type heat exchangers
4	plate type heat exchanger

Proposed Theory + Practical Evaluation Scheme by Academicians (% Weightage Category Wise and it's Marks Distribution)					
L:	**5**	**T:**	**0**	**P:**	**2**
Note: In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject. Each Test will be of 25 Marks. Each Test Syllabus Weightage: Range should be 20% - 30%					
Group (Theory or Practical)	**Group (Theory or Practical) Credit**	**Total Subject Credit**	**Category**	**% Weightage**	**Marks Weightage**
Theory	**5**	**6**	MCQ	42%	50
Theory			Theory Descriptive	12%	15
Theory			Formulas and Derivation	12%	15
Theory			Numerical	17%	20
Expected Theory %	**83%**		**Calculated Theory %**	**83%**	**100**
Practical	**1**		Individual Project	0%	0
Practical			Group Project	7%	40
Practical			Internal Practical Evaluation (IPE)	10%	60
Practical			Viva	0%	0
Practical			Seminar	0%	0
Expected Practical %	**17%**		**Calculated Practical %**	**17%**	**100**
Overall %	**100%**			**100%**	**200**

Course Outcome	
1	To understand and apply principles of heat transfer, including Fourier's law, convection mechanisms, and insulation optimization, to analyze and solve practical engineering problems.
2	To analyze natural and forced convection phenomena and understand principles of radiation including laws, properties of surfaces, and transfer between surfaces,
3	To Understand and apply principles of heat transfer during phase change phenomena, including boiling, condensation, and evaporator systems in various industrial processes.
4	To understand the principles and applications of diverse heat exchange equipment and flow arrangements to optimize heat transfer efficiency in industrial processes.
Suggested Reference Books	
1	"Unit Operations of Chemical Engineering", McCabe W L, Smith J C, Harriott P, McGraw Hill, 7th Ed. 2005.
2	**"**Unit Operation – I", K A Gavhane, Nirali Prakashan.
3	"Heat Transfer", J. P. Holman, McGraw Hill, Ninth Edition.
4	"Process Heat Transfer", D. Q. Kern, McGraw Hill.
5	"Heat Transmission", W. H. McAdams, McGraw Hill, 3rd Edition.

List of Open Source Software/Learning website	
1	https://onlinecourses.nptel.ac.in/noc20_ch12/preview

Practical Project/Hands on Project		
Sr. No.	**Project List**	**Linked with Unit**
1	Desalination with the help of Solar radiation.	Unit 1
2	Hot fluid and cold fluid interaction in beaker, to understand the concept of density and convective flow.	Unit 1
3	Finding of temperature gradient in Iron rod with variation in burner flame.	Unit 2
4	Finding of Reynolds number for Hot and cold fluid with respect to each laminar and turbulent flow.	Unit 3
5	Greenhouse effect in two glass boxes, where one glass box consisting black coated surface.	Unit 4
6	Compare various Analogy used in heat transfer	Unit 5
7	Creation of cyclone effect in glass box with controlled environment. (Forced convection)	Unit 5
8	Thermal emission of body with respect to color in enclosed environment.	Unit 6
9	Compare Film wise and Dropwise Condensation	Unit 7
10	Desalination of water with the help of solar radiation. Include various salt concentrations for same environment.	Unit 8
11	Design fin-type structure on metallic glass, find out temperature difference after addition of fin.	Unit 10