LOK JAGRUTI UNIVERSITY (LJU)

INSTITUTE OF ENGINEERING AND TECHNOLOGY

Department of Mechanical Engineering (710)

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

Course Code:	**017103591**
Course Name:	**Heat Transfer**
Category of Course:	Professional Core Course (PCC)
Prerequisite Course:	Mathematics 1 (017101191), Physics (017101192), Electrical and Electronics Engineering (017102292), Thermodynamics 1 (017103301), Fluid Mechanics (017103491)

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	**Conduction: 1-D Steady State Heat Conduction**			**9 (18%)**
	1.1 Modes of heat transfer			
	1.2 Thermal conductivity and diffusivity			
	1.3 Heat conduction through plane and composite walls	Basic differentiation and integration (017101191-Unit-03)		
	1.4 Heat conduction through hollow and composite cylinders and spheres		2.4 Critical thickness of Insulation(017103591-Unit-02)	
	1.5 Electrical analogy and overall heat transfer coefficient	DC circuits (017102292-Unit-01) Modes of heat transfer (017103591-Unit-1.1)	---	
	1.6 Critical thickness of Insulation	Steady state heat conduction (017103591-Unit-1.1, 1.2, 1.3)	---	
02	**Heat Transfer from Extended Surface**			**6 (12%)**
	2.1 Purpose of fins and heat flow through rectangular fin	Modes of heat transfer (017103591-Unit-1.1), Basic differentiation and integration (017101191-Unit-03)	---	
	2.2 Infinitely long fin and fin insulated at the tip		---	
	2.3 Fin losing heat at the tip of finite length		---	
	2.4 Efficiency and effectiveness of	All cases of fin	---	

	fin.	(017103591-Unit-2.1, 2.2, 2.3)		
03	**Conduction: Unsteady State Heat Conduction**			**3 (6%)**
	3.1 Lump system	Heat capacity (017103301-Unit-1), Basic differentiation and integration (017101191-Unit-03)	---	
	3.2 Transient heat conduction		---	
04	**Convection: Forced Convection**			**5 (10%)**
	4.1-Dimensional analysis applied to forced convection	Dimensional analysis (017103491-Unit-7)	---	
	4.2 Dimensional less numbers-Reynolds, Prandtl, Stanton	Reynolds number (017103491-Unit-10.1)	---	
	4.3 Thermal and hydrodynamic boundary layer thicknesses	---	---	
	4.4 Empirical correlations for forced convection (Flat plate, cylinder, tube)	---	---	
05	**Convection: Free Convection**			**5 (10%)**
	5.1-Dimensional analysis applied to free convection	Dimensional analysis (017103491-Unit-7)	---	
	5.2 Characteristic length or equivalent diameter	---	---	
	5.3 Dimensional less numbers-Nusselt, Grashoff, Prandtl	---	---	
	5.4 Empirical correlations for free convection (Flat plate, cylinder, tube)	---	---	
06	**Thermal Radiation: Basic Relations**			**5 (10%)**
	6.1 Electromagnetic waves and its spectrum	Waves (017101192-Unit-05)	---	
	6.2 Stefan-Boltzmann law	Modes of heat transfer (017103591-Unit-1.1)	---	
	6.3 Radiation properties (Emission properties absorption and reflection of radiant energy, emission, black and non-black bodies)	Waves (017101192-Unit-05)	---	
	6.4 Laws of radiation – Planck, Wein's displacement, Kirchhoff	---	---	
	6.5 Intensity of radiation and solid angle, Lambert's cosine law.	Trigonometry and geometry (017101191-Unit-02)		
07	**Thermal Radiation Between Surfaces**			**5 (10%)**
	7.1 Radiation heat exchange between black surface	Intensity of radiation and solid angle (017103591-Unit-7.5)	---	
	7.2 Geometric configuration factor	---	---	
	7.3 Grey body radiation exchange between surfaces of unit configuration factors	---	---	
	7.4 Electrical analogy to simple problems and radiation shield	DC circuits (017102292-Unit-01)	---	
08	**Heat Exchangers analysis by LMTD Method**			**5 (10%)**
	8.1 Classification and analysis of heat	Heat capacity		

	exchanger	(017103301-Unit-1)		
	8.2 LMTD calculation for parallel flow heat exchanger	Heat capacity (017103301-Unit-1), Basic differentiation and integration (017101191-Unit-03)	9.1 & 9.2 Effectiveness – NTU method for parallel &counter flow heat exchanger (017103591-Unit-09)	
	8.3 LMTD calculation for counter flow heat exchanger			
	8.4 Fouling factors and overall heat transfer coefficient	---	---	
09	**Heat Exchangers analysis by NTU Method**			**5 (10%)**
	9.1 Heat exchanger Effectiveness & Number of transfer unit	---	---	
	9.2 Effectiveness – NTU method for parallel flow heat exchanger	LMTD for Parallel & Counter flow Heat exchanger (017103591-Unit-08)	---	
	9.3 Effectiveness – NTU method for counter flow heat exchanger		---	
10	**Application of Solar Heat Transfer (Only Theory)**			**2 (4%)**
	10.1 Introduction	---	---	
	10.2 Solar Radiation Geometry (Altitude angle, Zenith angle, Azimuth angle)	---	---	
	10.3 Natural Circulation Solar Water Heater	Modes of Heat transfer (017103591-Unit-01)	---	
	10.4 Forced Circulation Solar Water Heater		---	
	10.5 Passive Solar Distillation (Single slope solar still)		---	

Major Components/ Equipment

Sr. No.	Component/Equipment
1	Thermal conductivity measuring apparatus by spherical method
2	Thermal conductivity measuring apparatus by cylindrical method
3	Pin fin apparatus
4	Natural convection apparatus
5	Forced convection apparatus
6	Stefan-Boltzmann apparatus
7	Emissivity measurement apparatus

Sr No.	Practical Title	Link to Theory Syllabus
1	To find thermal conductivity of insulating powder by spherical method	Unit-1
2	To find thermal conductivity of a given insulating materials by cylindrical method	Unit-1
3	To find heat transfer through pin fin apparatus	Unit-2
4	To find surface heat transfer coefficient for force convection heat transfer	Unit-4
5	To find out coefficient of natural convection	Unit-5
6	To find emissivity of given plate	Unit-6

7	To find Stefan Boltźman constant by Stefan Boltźman apparatus	Unit-6
8	To determine heat loss in Pipe-in-Pipe heat exchanger	Unit-8

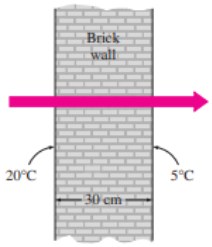
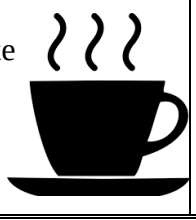
Proposed Theory + Practical Evaluation Scheme by Academicians (% Weightage Category Wise and it's Marks Distribution)					
L :	**5**	**T:**	**0**	**P:**	**2**
Note : In Theory Group, Total 4 Test (T1+T2+T3+T4) will be conducted for each subject. **Each Test will be of 25 Marks.** **Each Test Syllabus 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	16%	19
Theory			Theory Descriptive	0%	0
Theory			Formulas and Derivation	34%	40
Theory			Numerical	34%	41
Expected Theory %	**84%**		**Calculated Theory %**	**84%**	**100**
Practical	**1**		Individual Project	0%	0
Practical			Group Project	0%	0
Practical			Internal Practical Evaluation (IPE)	11%	70
Practical			Viva	5%	30
Practical			Seminar	0%	0
Expected Practical %	**16%**		**Calculated Practical %**	**20%**	**100**
Overall %	**100%**			**100%**	**200**

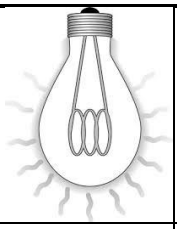
Course Outcome	
	Upon completion of the course students will be able to
1	identify the modes of heat transfer for given practical applications
2	analyze the performance of convective heat transfer coefficient for free and force convection.
3	apply the concepts of radiation heat transfer phenomena.
4	evaluate and design of heat exchanger and understand the basic concept of heat transfer for solar thermal applications.

Suggested Reference Books	
1	Heat and Mass Transfer by R K Rajput, S.Chand Publication
2	Heat and Mass Transfer: Fundamentals and Application by Yunus Cengel, McGraw Hill
3	Heat and Mass Transfer by P.K. Nag, McGraw Hill
4	Heat Transfer by J P Holman, McGraw Hill
5	Heat Transfer: Principles and Applications by Dutta, Binay K, PHI Publication
6	R. C. Sachdeva, Fundamentals of Heat and Mass Transfer, New Age International Publications, 2012.

List of Open Source Software/Learning website	
1	nptel.ac.in
2	Cosmolearning.org
3	www.learnerstv.com
4	MIT OCW lecture on introduction to heat transfer
5	Engineering Wikia-Heat Transfer
6	Heat and Mass Transfer – Mechanical Engineering Handbook

Practical Project/Hands on Project

Sr. No.	Project List	Linked with Unit
1	**Measure the Thermal Conductivity of a Material.** Determine the thermal conductivity of the sample with the help of thermocouple and heater.	Unit 01
2	**Heat Loss through a Wall**  Find out heat loss from the wall of your house on particular day. Data needs 1. Hight, Width and Thickness of the wall 2. Thermal conductivity of the material of the wall Inner and outer surface temperature of the wall	Unit 01
3	**Increase heat transfer rate of radiator wall by using extended surfaces. (Fins)**  Data needs 1. Temperature of wall 2. Extended surface's material properties and dimensions Surrounding fluid thermal properties	Unit 02
4	**Predicting the Time of Death** A person is found dead at particular time in a room. From the temperature of the body find out the time when he was died	Unit 03
5	**Cooling by Forced air** If there is a hot cup of tea on a table under a fan. Find out heat transfer rate by convection mode of heat transfer for both conditions. 1. When fan is off 2. When fan is on 	Unit 04,05

6	**Emission of Radiation (Visible Range) from a Lightbulb** The temperature of the filament of an incandescent lightbulb is 2500 K. Assuming the filament to be a blackbody, determine the fraction of the radiant energy emitted by the filament that falls in the visible range		Unit 06,07
7	**Design Heat Exchanger** Design heat exchanger for cool of hot water.		Unit 08,09
8	**Heat Transfer Analysis of Solar Water Heater** To understand heat transfer analysis of Solar water heater.		Unit 10