Course Syllabus
Gyanmanjari Institute of Technology
Semester-5(B. Tech)

Subject: Heat Transfer-BETME15311

Type of course: Professional Core

Prerequisite: Engineering Thermodynamics and Basic knowledge of Fluid Mechanics

Rationale: This course is designed to provide a detailed understanding of different modes of heat transfer and their applications in Mechanical Engineering. It also offers fundamental technical knowledge of heat exchangers, including their principles, design, and practical applications.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks					Total Marks
				Theory Marks		Practical Marks		CA	
CI	T	P	C	ESE	MSE	V	P	ALA	
4	0	2	5	60	30	10	20	30	150

Legends: CI-Classroom 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:

Unit No	Course content	Hrs.	% Weightage
1	**Conduction** **Introduction:** modes of heat transfer – basic laws of heat transfer – general applications of heat transfer. Fourier's law, effect of temperature on thermal conductivity of different solids, liquids and gases, generalized equation in Cartesian, cylindrical and spherical coordinates and its reduction to specific cases, One dimensional steady state conduction, heat conduction through plane and composite walls, cylinders and spheres, electrical analogy, critical radius of insulation for cylinder and sphere, overall heat transfer coefficient **Heat transfer from extended surface:** Types of fins, heat flow through uniform cross-sectional area fin for various cases like infinitely long fin, fin insulated at the tip and fin losing heat at the tip, efficiency and effectiveness of fin, Estimation of error in temperature measurement in a thermometer well **Transient heat conduction:** Lumped capacitance method for bodies of infinite thermal conductivity, time constant, one-dimensional transient heat conduction in plane wall with finite conduction and convective resistances	20	30
2	**Convection** Newton's law of cooling, dimensional analysis applied to forced and free convection, dimensionless numbers and their physical significance, empirical correlations for free and forced convection, Continuity, momentum and energy equations, thermal and hydrodynamic boundary layer, Blasius solution for laminar boundary layer, General solution for Von-Karman integral momentum equation	15	25
3	**Radiation** Absorptivity, reflectivity and transmissivity, black, white and grey body, emissive power, emissivity, Kirchhoff's law, Planck's law, Rayleigh-Jeans' law, Wien's law, Wien's displacement law, Stefan-Boltzmann law, Intensity of radiation, Radiation heat exchange between black bodies, Shape factor, Electrical analogy, Radiation heat exchange between gray bodies, Radiosity, Irradiation, Radiation shields	15	25
4	**Heat Exchangers** Classification, Heat exchanger analysis, LMTD for parallel and counter flow exchanger, Condenser and evaporator, Overall heat transfer coefficient, fouling factor, Correction factors for multi pass arrangement, Effectiveness-NTU method for parallel and counter flow heat exchanger, Introduction of heat pipe and compact heat exchanger	10	20

Continuous Assessment:

Sr. No	Active Learning Activities	Marks
1	**Heat Transfer Rate** Each group of students will conduct an experiment to measure heat transfer through a given material. Using Fourier's law, they will calculate the heat transfer rate of the material. Students will then analyze heat transfer through a plain wall, measuring the temperature differences across various materials. The findings, including calculations and observations, should be compiled into a brief report with diagrams and uploaded to the GMIU portal.	10
2	**Critical radius of insulation** Demonstrate the critical radius of insulation concept for cylinders and spheres by varying insulation thicknesses (5 mm, 10 mm, 15 mm, and 20 mm). Generate a comparison plot using Microsoft Word or Excel and upload it on the GMIU web portal.	10
3	**Design of heat exchanger** Design and analyze a heat exchanger using faculty allocated data by applying the Log Mean Temperature Difference (LMTD) and Effectiveness-NTU (ε-NTU) methods using Microsoft Excel upload it on the GMIU web portal.	10
	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 %	40 %	20 %	-	-

Course Outcome:

After learning the course, the students should be able to:	
CO1	Analyze the various modes of heat transfer and apply basic heat conduction equations for a steady one-dimensional thermal system.
CO2	Understand the principles of convective heat transfer.
CO3	Understand and analyze the radiation heat transfer.
CO4	Recognize the methodology for designing heat exchangers using the LMTD and NTU.

List of Practical:

Sr. No	Descriptions	Unit No	Hrs.
1	To determine the thermal conductivity of given metal rod.	1	4
2	To determine the thermal conductivity of the given composite walls.	1	2
3	To measure convective heat transfer co-efficient and effectiveness of the fin under forced and natural convection.	1	4
4	To determine heat transfer co-efficient for transient heat transfer process.	1	4
5	To determine critical radius of insulation.	1	2
6	To determine heat, transfer co-efficient by forced and natural convection.	2	4
7	To determine the emissivity of gray body.	3	2
8	To determine the emissivity of black body.	3	2
9	To determine Stephan Boltzmann constant experimentally.	4	2
10	To determine the overall heat, transfer co-efficient of shell and tube type heat exchangers.	4	4
		Total	30

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.

Students will use supplementary resources such as online videos, NPTEL/SWAYAM videos, e-courses, Virtual Laboratory

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] Heat Transfer, Holman J. P., Mc Graw-Hill, 9th Ed., 2008.

[2] Heat and Mass Transfer, Kumar D. S., Kataria & Sons Publications.

[3] Heat and Mass Transfer, Rajput R. K., S. Chand Publications.

[4] Heat and Mass Transfer, Cengel Y. A., Mc Graw-Hill, 4th Ed., 2015

[5] Principles of Heat Transfer, Frank K. & Bohn M., the University of Michigan, 6th Ed., 2011.