HEAT TRANSFER

PROF. SUNANDO DASGUPTA
Department of Chemical Engineering
IIT Kharagpur

PRE-REQUISITES : Undergraduate level courses in Fluid Mechanical

INTENDED AUDIENCE : Chemical/Mechanical/Biotechnology/Nanotechnology

INDUSTRIES SUPPORT : Most of the process industries recognize this as a fundamental course dealing with the design of the heat transfer equipment. The fundamental concepts will enhance the lateral thinking capabilities of the students and seamlessly integrate the concepts for their use in a multitude of processes and problems. The relevant industries include all chemical process industries, thermal, solar and nuclear power as well as those involved in the design of such plants.

COURSE OUTLINE :

This is a fundamental subject for Chemical Engineering students and is also important in disciplines as diverse as Mechanical Engineering, Biotechnology and Nanotechnology. This course deals with both the fundamental and applied aspects, starting with the basic concepts and governing equations and evolving into the design of relevant industrial units. The students will be made aware of the core scientific issues and will be encouraged to solve problems on their own.

ABOUT INSTRUCTOR :

Prof. Sunando DasGupta is a professor of Chemical Engineering and was the Dean of Sponsored Research at the Indian Institute of Technology Kharagpur. He obtained his Bachelor's degree from the Jadavpur university, Masters from IIT Kanpur and PhD from the Rensselaer Polytechnic Institute, USA in 1992. His research interests are in the fields of microscale transport processes and microfluidics and he has over 140 publications in peer reviewed journals. Prof. DasGupta is a Fellow of the National Academy of Engineering, has received the Herdillia Award by the Indian Institute of Chemical Engineers for excellence in Basic Research in Chemical Engineering and is a Senior Associate of the Abdus Salam International Centre for Theoretical Physics, Trieste, Italy.

COURSE PLAN :

Week 1 : Physical Origins and Rate Equations, Units and Dimensions, Relevance, Analysis of Heat Transfer Problems: Methodology, Introduction to Conduction, The Conduction Rate Equation, The Thermal Properties of Matter,
Week 2 : The Heat Diffusion Equation, Boundary and Initial Conditions, One-Dimensional, Steady-State Conduction, The Plane Wall, Radial Systems,
Week 3 : Conduction with Thermal Energy Generation, Heat Transfer from Extended Surfaces, Introduction to Two-Dimensional, Steady-State Conduction
Week 4 : Transient Conduction, The Lumped Capacitance Method, The Plane Wall with Convection, Radial Systems with Convection, The Semi-Infinite Solid
Week 5 : The Convection Boundary Layers, Local and Average Convection Coefficients, Laminar and Turbulent Flow, Thermal Boundary Layer Equations and Similarity, The Normalized Boundary Layer Equations, Boundary Layer Analogies
Week 6 : External Flow, Convection Calculations, The Flat Plate in Parallel Flow, The Cylinder in Cross Flow, Flow Across Banks of Tubes
Week 7 : Internal Flow, Laminar Flow in Circular Tubes: Thermal Analysis and Convection Correlations for Turbulent Flow in Circular, Non-Circular and Concentric Tube Annulus
Week 8 : Free Convection, The Governing Equations for Laminar Boundary Layers, Laminar Free Convection on a Vertical Surface, The Effects of Turbulence, Empirical Correlations for External Free Convection Flows and Within Parallel Plate Channels, Combined Free and Forced Convection
Week 9 : Boiling and Condensation, Boiling Modes, Forced Convection Boiling, Condensation - laminar and Turbulent Film in Different Geometries, Dropwise Condensation
Week 10 : Heat Exchangers, The Overall Heat Transfer Coefficient, Heat Exchanger Analysis: Use of the Log Mean Temperature Difference, Heat Exchanger Analysis: The Effectiveness–NTU Method, Heat Exchanger Design and Performance Calculations
Week 11 : Radiation, Fundamental Concepts, Blackbody Radiation, Absorption, Reflection, and Transmission by Real Surfaces, Kirchhoff's Law, The Gray Surface
Week 12 : Radiation Exchange Between Surfaces - The View Factor, Blackbody Radiation Exchange, Radiation Exchange Between Opaque, Diffuse, Gray Surfaces in an Enclosure, Radiation Exchange with Participating Media