HEAT TRANSFER

PROF. GANESH VISWANATHAN

Department of Chemical Engineering

IIT Bombay

PRE-REQUISITES : Linear algebra, Fluid Mechanics

INTENDED AUDIENCE : Undergraduate and graduate students from Chemical and Mechanical Engineering, College teachers, Process engineers

INDUSTRIES SUPPORT : Reliance, HPCL, BPCL, RCF, Other chemical and petrochemical industries

COURSE OUTLINE : Heat transfer occurs in many unit operations in variety of processes in chemical, petrochemical, power and pharmaceutical industries. Understanding the fundamentals governing heat transfer is key to designing equipment that involves heat exchange. This course for undergraduate students covers the fundamental aspects and quantitation of different modes of heat transport. The course can also serve as a refresher for graduate students

ABOUT INSTRUCTOR :
Prof. Ganesh Viswanathan is an Associate Professor in Department of Chemical Engineering at Indian Institute of Technology Bombay, Mumbai. He completed his Ph.D in Chemical Engineering from University of Houston, Houston and Postdoctoral Fellowship at Mount Sinai School of Medicine, New York. He conducts research in systems biology of signaling networks and nonlinear dynamics of reactors. Further information about his research and teaching activities is available at http://www.che.iitb.ac.in/faculty/ganesh/

COURSE PLAN :

Week 1
Lecture 1: Introduction
Lecture 2: Introduction to Conduction
Lecture 3: Energy Balance
Lecture 4: 1D Steadystate Conduction - Resistance Concept
Lecture 5: Resistances in Composite Wall Case

Week 2
Lecture 6: Resistances in Radial systems
Lecture 7: Heat Generation I : Plane and Cylindrical Wall
Lecture 8: Introduction to Extended Surfaces
Lecture 9: Extended Surfaces I : General formulation
Lecture 10: Extended Surfaces II - Uniform Cross-sectional Area

Week 3
Lecture 11: Extended Surfaces III – Varying Cross-section area
Lecture 12: 2D Plane wall
Lecture 13: Transient Analyses I : Lumped Capacitance Method
Lecture 14: Transient Analyses II : Full Method
Lecture 15: Transient Analyses : Semi-infinite Case

Week 4
Lecture 16: Introduction to Convective Heat Transfer
Lecture 17: Heat and Mass Transport Coefficients
Lecture 18: Boundary Layer : Momentum,Thermal and Concentration
Lecture 19: Laminar and Turbulent Flows ; Momentum Balance
Lecture 20: Energy and Mass Balances ; Boundary Layer Approximations

Week 5
Lecture 21: Order of Magnitude Analysis
Lecture 22: Transport Coefficients
Lecture 23: Relationship between Momentum,Thermal and Concentration boundary Layer
Lecture 24: Reynolds and Chilton-Colburn Analogies
Lecture 25: Forced Convection : Introduction

Week 6
Lecture 26: Flow Past Flat Plate I – Method of Blasius
Lecture 27: Flow Past Flat Plate II - Correlations for Heat and Mass Transport
Lecture 28: Flow Past Cylinders
Lecture 29: Flow through Pipes I
Lecture 30: Flow through Pipes II

Week 7
Lecture 31: Flow through Pipes III
Lecture 32: Flow through Pipes IV – Mixing-cup Temperature
Lecture 33: Flow through Pipes V – Log mean Temperature difference
Lecture 34: Flow through Pipes VI – Correlations for Laminar and Turbulent Conditions
Lecture 35: Example problems : Forced Convection

Week 8
Lecture 36: Introduction to Free/Natural Convection
Lecture 37: Heated plate in a quiescent fluid- I
Lecture 38: Heated plate in a quiescent fluid- II
Lecture 39: Boiling I
Lecture 40: Boiling II

Week 9
Lecture 41: Condensation : I
Lecture 42: Condensation : II
Lecture 43: Radiation : Introduction
Lecture 44: Spectral Intensity
Lecture 45: Radiation : Spectral properties,Blackbody

Week 10
Lecture 46: Properties of a Blackbody
Lecture 47: Surface Adsorption
Lecture 48: Kirchoff’s Law
Lecture 49: Radiation Exchange - View Factor
Lecture 50: View Factor Examples

Week 11
Lecture 51: View factor - Inside Sphere Method, Blackbody Radiation Exchange
Lecture 52: Diffuse, Gray Surfaces in an Enclosure
Lecture 53: Resistances - Oppenheim matrix method
Lecture 54: Resistances - Examples
Lecture 55: More Examples : Volumetric Radiation

Week 12
Lecture 56: Introduction and Examples
Lecture 57: Parallel Flow Heat Exchangers
Lecture 58: LMTD I
Lecture 59: Shell and Tube Heat Exchangers
Lecture 60: Epsilon-NTU Method