University of Sistan and

Baluchestan

Department of Mechanical Engineering

Heat transfer I

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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

COURSE DETAIL

Module No.	Topic/s	Lectures
1	**INTRODUCTION AND BASIC CONCEPTS** 1–1 Thermodynamics and Heat Transfer Application Areas of Heat Transfer 1–2 Engineering Heat Transfer Modeling in Engineering 1–3 Heat and Other Forms of Energy Specific Heats of Gases, Liquids, and Solids Energy Transfer 1–4 The First Law of Thermodynamics Energy Balance for Closed Systems Energy Balance for Steady-Flow Systems Surface Energy Balance 1–5 Heat Transfer Mechanisms 1–6 Conduction Thermal Conductivity	3

	Thermal Diffusivity 1–7 Convection 1–8 Radiation 1–9 Simultaneous Heat Transfer Mechanisms 1–10 Prevention Through Design 1–11 Problem-Solving Technique	
2	**HEAT CONDUCTION EQUATION** 2–1 Introduction Steady versus Transient Heat Transfer Multidimensional Heat Transfer Heat Generation 2–2 One-Dimensional Heat Conduction Equation Heat Conduction Equation in a Large Plane Wall Heat Conduction Equation in a Long Cylinder Heat Conduction Equation in a Sphere Combined One-Dimensional Heat Conduction Equation 2–3 General Heat Conduction Equation Rectangular Coordinates Cylindrical Coordinates Spherical Coordinates 2–4 Boundary and Initial Conditions Specified Temperature Boundary Condition Specified Heat Flux Boundary Condition Special Case: Insulated Boundary Another Special Case: Thermal Symmetry Convection Boundary Condition Radiation Boundary Condition Interface Boundary Conditions Generalized Boundary Conditions 2–5 Solution of Steady One-Dimensional Heat Conduction Problems 2–6 Heat Generation in a Solid 2–7 Variable Thermal Conductivity	3
3	**STEADY HEAT CONDUCTION** 3–1 Steady Heat Conduction in Plane Walls Thermal Resistance Concept Thermal Resistance Network Multilayer Plane Walls 3–2 Thermal Contact Resistance 3–3 Generalized Thermal Resistance Networks 3–4 Heat Conduction in Cylinders and Spheres	3

	Multilayered Cylinders and Spheres 3–5 Critical Radius of Insulation 3–6 Heat Transfer from Finned Surfaces Fin Equation Fin Efficiency Fin Effectiveness Proper Length of a Fin 3–7 Bioheat Transfer Equation 3–8 Heat Transfer in Common Configurations	
4	**TRANSIENT HEAT CONDUCTION** 4–1 Lumped System Analysis Criteria for Lumped System Analysis Some Remarks on Heat Transfer in Lumped Systems 4–2 Transient Heat Conduction in Large Plane Walls, Long Cylinders, and Spheres with Spatial Effects Nondimensionalized One-Dimensional Transient Conduction Problem Exact Solution of One-Dimensional Transient Conduction Problem Approximate Analytical and Graphical Solutions 4–3 Transient Heat Conduction in Semi-Infinite Solids Contact of Two Semi-Infinite Solids 4–4 Transient Heat Conduction in Multidimensional Systems	2
5	**NUMERICAL METHODS IN HEAT CONDUCTION** 5–1 Why Numerical Methods? 1 Limitations 2 Better Modeling 3 Flexibility 4 Complications 5 Human Nature 5–2 Finite Difference Formulation of Differential Equations 5–3 One-Dimensional Steady Heat Conduction 5–4 Two-Dimensional Steady Heat Conduction Boundary Nodes Irregular Boundaries 5–5 Transient Heat Conduction Transient Heat Conduction in a Plane Wall Two-Dimensional Transient Heat Conduction	3

REFERENCES

HEAT AND MASS TRANSFER, FUNDAMENTALS & APPLICATIONS / Yunus A. Çengel, Afshin J. Ghajar

ADDITIONAL READINGS

Fundamentals of Heat and Mass Transfer / Bergman, Lavine, Incropera, Dewitt