FACULTY OF **ENGINEERING**

DEGREE COURSE: **INDUSTRIAL ENGINEERING**

MASTER DEGREE: **INDUSTRIAL ENGINEERING / ENERGY**

SUBJECT: HEAT TRANSFER

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OBJECTIVES

The course aims at providing the basic knowledge necessary for the treatment of problems related to heat transfer. The main objective is the acquisition of knowledge about general mechanisms, equations and methods of solution applicable to problems of heat transfer.

CONTENTS

introduction
1. Principles of thermodynamics and conservation laws
2. General information on the mechanisms of heat exchange

Thermal conduction
1. Fourier Law
2. Conductivity of materials
3. General equation of thermal conduction

Steady thermal conduction
1. One-dimensional Steady thermal conduction
2. One-dimensional Steady thermal conduction with internal generation
3. Multi-dimensional Steady thermal conduction

Unsteady Thermal conduction
1. Uniform temperature systems
2. Non uniform temperature systems
3. Stabilized periodic regime in a semi-infinite medium

Thermal convection
1. Features of thermal convection
2. Kinematic and thermal Boundary layer
3. Boundary layer equations and energy equation
4. Thin and thick boundary layers

Forced Convection
1. Forced convection in external flows
2. Forced convection in pipes and channels

Natural Convection
1. Natural convection in external flows
2. Natural convection in confined spaces
3. Natural convection in vertical channels

Heat Transfer in Boiling and Condensation
1. Regimes of boiling in a fluid
2. Boiling nucleation
3. Thermal crisis and film boiling
4. Boiling in forced convection
5. Condensation general characteristics
6. Condensation on vertical surface
7. Condensation in tube banks or horizontal slab
8. Condensation drops
9. Effect of incondensable gases on condensation

Thermal radiation, fundamental concepts
1. Black body radiation
2. Emission by the surfaces and gray bodies
3. Radiation properties of bodies
4. Principle of Kirchhoff
5. Solar Radiation and greenhouse effect

Heat exchange by radiation
1. Exchange between two black bodies,
2. Calculation of the form factor
3. Radiation in cavities
4. Heat transfer between gray surfaces
5. Infrared thermography

Heat Exchangers
1. Outline and classification
2. The global heat transfer coefficient
3. The logarithmic mean temperature difference
4. Analysis by the epsilon-NTU method
5. Heat exchangers design
6. The solar collectors

Heat exchange in Electronics

LEARNING OUTCOMES

At the end of the course, students will have acquired the necessary tools to identify the heat transfer mechanisms operating within devices and components. Students will also be able to solve the equations governing the problems of heat transfer and make a preliminary thermal design.

ASSESSMENT

Written exam: multiple-choice tests and open-ended questions

RECOMMENDED TEXTBOOKS

- G. Guglielmini, C. Pisoni "Elementi di Trasmissione del calore", Masson Editoriale Veschi
- Bejan, A.D. Krauss "Heat Transfer handbook" John Wiley and Sons