



# NATIONAL UNIVERSITY OF ENGINEERING COLLEGE OF MECHANICAL ENGINEERING

## MECHANICAL-ELECTRICAL ENGINEERING PROGRAM

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### MN310 – HEAT TRANSFER

#### I. GENERAL INFORMATION

<b>CODE</b>	: MN310 Heat Transfer
<b>SEMESTER</b>	: 7
<b>CREDITS</b>	: 3
<b>HOURS PER WEEK</b>	: 4 (Theory–Practice)
<b>PREREQUISITES</b>	: MB536 Numerical Methods, MN217 Fluid Mechanics II
<b>CONDITION</b>	: Compulsory
<b>DEPARTMENT</b>	: Mechanical Engineering

#### II. COURSE DESCRIPTION

The course prepares students in the understanding and application of heat transfer processes in mechanical and thermal systems. Students understand the mechanisms of heat transfer, fundamental equations, heat transfer in flat and curved walls, heat with extended surfaces, radiant exchange between surfaces, and natural and forced convection. Students complete the design of a heat exchanger satisfying given requirements and constraints.

#### III. COURSE OUTCOMES

At the end of the course, students:

1. Explain the forms of heat transfer and represent them by mathematical expressions.
2. Solve specific problems related to heat and mass transfer in electromechanical systems, and perform an appropriate numerical calculation.
3. Design heat exchangers for different requirements, applying proper techniques.

#### IV. LEARNING UNITS

##### 1. INTRODUCTION TO HEAT AND MASS TRANSFER MECHANISMS

Modes of heat transfer / Conduction, convection, radiation and multi-mode heat transfer / One-way conduction systems in permanent status / Critic radius of insulation / Mass transfer: molecular diffusion - Fick equation / Convective mass transfer / Mass transfer coefficient / Application problems.

##### 2. STATIONARY STATE CONDUCTION

Heat transfer differential equation / One-way conduction: systems with internal generation of heat, extended surfaces / Efficiencies of fins / Application problems / Two and three dimension systems: analytical, graphical and numerical solutions / Application problems.

##### 3. MOLECULAR DIFFUSION IN PERMANENT STATE

Mass transfer differential equation / One dimension mass transfer independent of chemical reactions / Equi-molar counter-diffusion. / One dimension systems associated with chemical reaction / Application problems.

##### 4. HEAT TRANSFER BY RADIATION

Heat radiation / Intensity of radiation / Law of Plank / Stefan-Boltzmann law / Emittance and absorbency of surfaces / Exchange of radiation (the factor of vision) / Exchange of heat between black surfaces by radiation / Volumetric gas radiation / Application problems.

##### 5. CONVECTIVE TRANSFER ANALYSIS

Exact analysis of the boundary layer on a flat wall / Thermal boundary layer / Concentration boundary layer / Approximate analysis of boundary layers / Analogy between transfer of momentum, energy and mass.

## 6. HEAT CONVECTIVE TRANSFER

Considerations about turbulent flow / Forced convection in external flow: crossed flow on cylinders and spheres / Bank of pipelines / Internal flow in forced convection: thermal boundary layer / Energy balance / Laminar flow / Turbulent flow / Non-circular ducts / Void section / Natural convection: laminar analysis on a vertical wall / Effects of turbulence / Empirical outside correlations of forced and free convection / Boiling in forced convection / Condensation, laminar condensation on a vertical wall / Condensation on cylinders and on fields / Application problems.

## 7. CONVECTIVE MASS TRANSFER

Correlations of convective mass transfer: mass transfer by plates, cylinders, and spheres / Mass transfer for internal flow in tubes / Mass transfer in interphases.

## 8. HEAT AND MASS TRANSFER EQUIPMENT

Heat exchanger / Thermal calculation of heat exchangers: Method of Average Logarithmic Difference of Temperatures (ALDT) / Number of Transfer Units Method. (NTU) / Cooling towers / Towers of continuous contact / Mass balance / Enthalpy balance / Capacity coefficients / Application problems.

## V. PRACTICAL EXPERIENCE

**Session 1:** Fundamentals of heat and mass transfer.

**Session 2:** Heat transfer by conduction, convection and radiation.

**Session 3:** Convective transference of mass.

**Session 4:** Identification of heat and mass transfer equipment.

## VI. METHODOLOGY

The course takes place in theory and practice sessions. In theory sessions faculty presents the theory, concepts and methods. In practice sessions, students apply theory to solve diverse problems related to heat and mass transfer in different engineering applications. Students also design a heat exchanger satisfying given requirements and constraints. At the end of the course, students submit and defend a final report. Student active participation is promoted throughout the course.

## VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

$$PF = (EP + 2*EF + PP) / 4$$

EP: Mid-term Exam      EF: Final Exam

PP: Average of Practical Works

## VIII. BIBLIOGRAPHY

1. INCROPERA, FRANK  
Fundamentals of Heat Transfer. 6<sup>th</sup> Edition, USA, 2007.
2. KAYS W.M/CRAWFORD M.E.  
Convective Heat and Mass Transfer. 3<sup>rd</sup> Edition, Mc. Graw–Hill Ed.
3. BIRD R. B.  
Transport Phenomena. 2<sup>nd</sup> Edition, New York, 2012